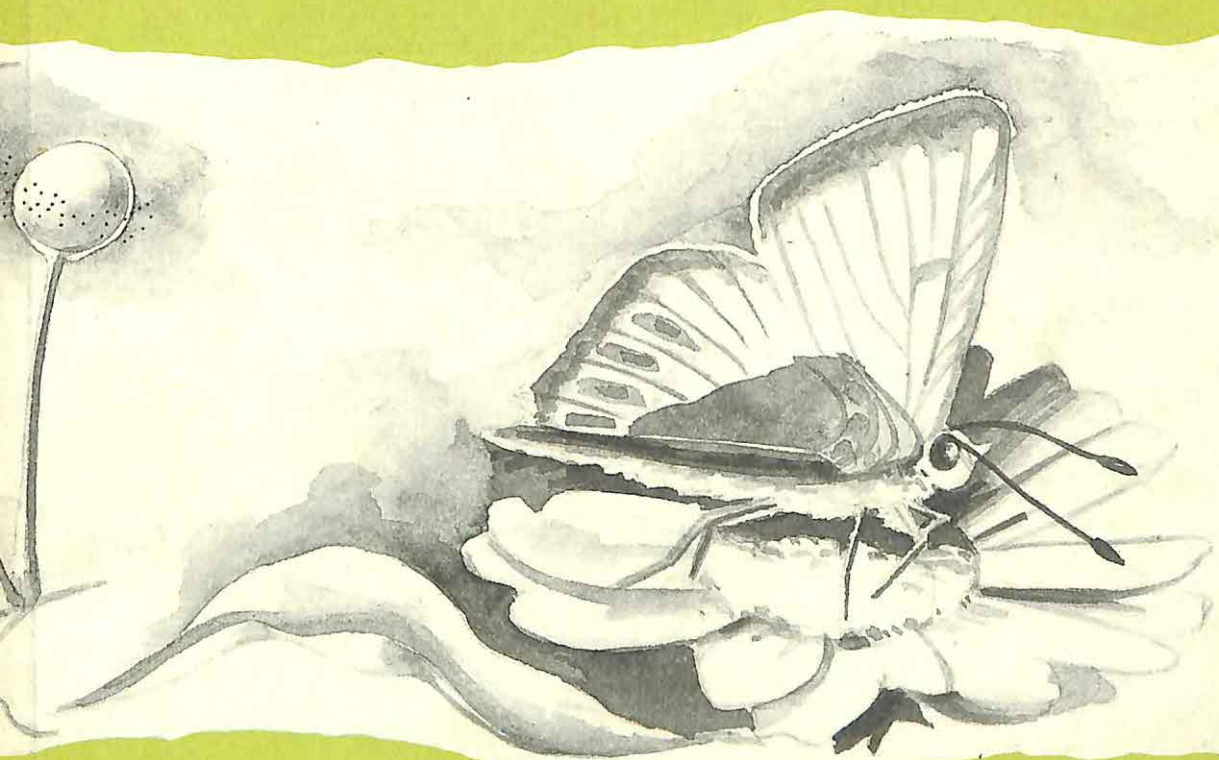
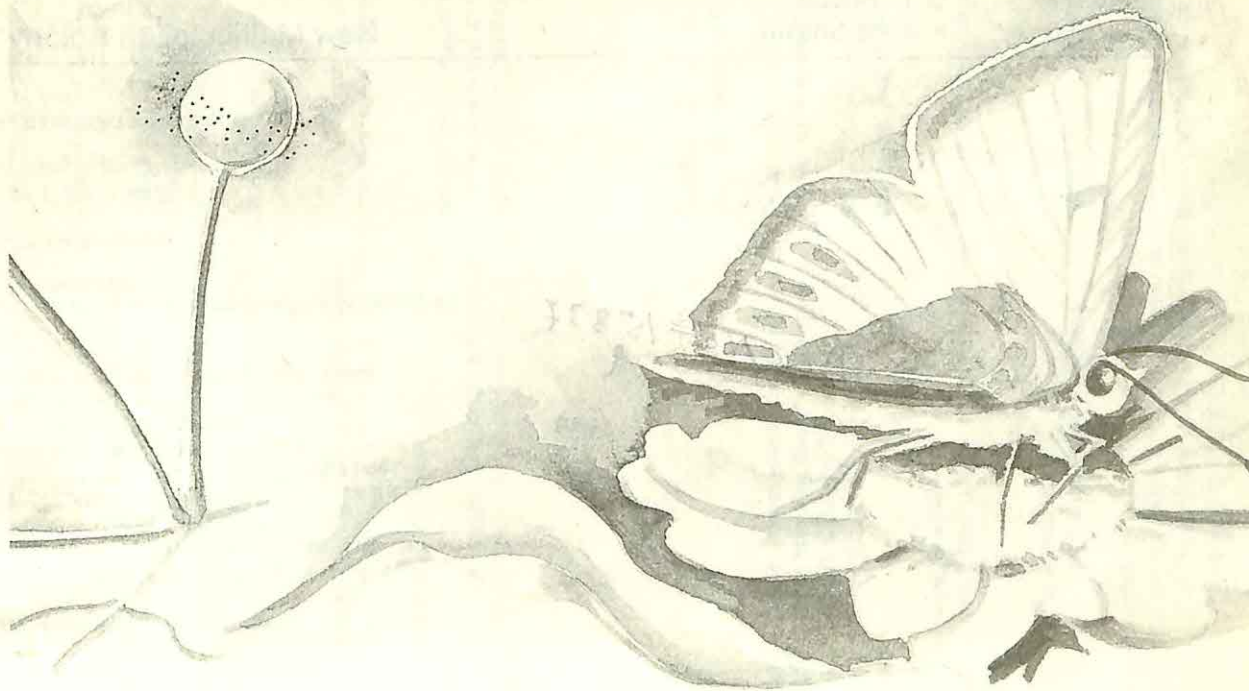


NEW MATRICULATION BOTANY



NEW MATRICULATION BOTANY 8

SHANTHA CHACKO, M.Sc., B.T.,
Bain Matriculation and Higher Secondary School
Kilpauk
Madras.



Orient Longman

To the teacher

New Matriculation Botany is a series of five books developed for class 6-10 of the Tamil Nadu Matriculation system. It closely follows the new enriched Matriculation syllabus.

One of the main features of the new syllabus is that activity and observation are given a very important place in understanding science. Every effort has been made to unfold the scope and purpose of the syllabus. This series departs from the conventional and emphasises a practical, 'discovery' and 'learning by doing' approach.

The subject matter to be studied has been carefully arranged keeping in mind the age level and psychology of the child. No effort has been spared to support the text with clear, labelled illustrations. The language has been kept simple and direct to enable the students to read the text themselves.

Several activities and projects have been suggested, wherever possible, within the scope of the lesson. Most of these need simple improvising or inexpensive materials.

The exercises for each chapter are exhaustive and include questions based on comprehension and application of basic principles rather than on mere recall.

It has been the concern of the authors that children are encouraged to discover for themselves the pleasure of learning about the fascinating world of 'plants'.

The author

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New Matriculation Botany 8

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17, Chittaranjan Avenue, Calcutta 700 072

160 Anna Salai, Madras 600 002

1/24 Asaf Ali Road, New Delhi 110 002

80/1 Mahatma Gandhi Road, Bangalore 560 001

3-6-272 Himayatnagar, Hyderabad 500 029 (A.P.)

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MATRICULATION SYLLABUS FOR STD VIII - BOTANY

<i>S.No.</i>	<i>Concept/Theme</i>	<i>Expected/Learning outcomes</i>	<i>Teaching/Learning Activities</i>
1.	Diversity of living organisms		
1.1	Scientific names	Recognises scientific names - generic and specific - and their universal application.	Comparison may be made with the first and surnames.
1.2	Methods of writing species, genus, family, natural order and class	Recognises ways of writing scientific names of plants.	Writes the scientific names of few common plants and their family/natural order, etc.,
1.3	Microorganisms	Recognises the smallness of microorganisms and the need for the microscope to see them.	The degree of magnification a simple microscope can make to view microorganisms can be explained by showing a microscope.
1.4	Differentiation between micro-and macroorganisms based on size	Discriminates microorganisms from macroorganisms of different criteria.	Observes bacteria under the microscope. Tabulates the differences among micro- and macroorganisms.
1.5	Contribution of Leeuwenhoek		
1.6	Viruses	Recognises virus particles in pictures.	Draws sketches of viruses.
1.7	Occurrence, discoveries, properties and diseases caused by viruses in man and plants	Recalls properties of viruses. Recalls viral diseases in man, plant and animals.	Visits a health centre and garden: discusses the viral diseases in man and plants. Prepares a chart under the following headings. 1. Name of the disease 2. Site of infection 3. Symptoms 4. Mode of transmission 5. Control measures
1.8	Bacteria	Discriminates between virus and bacteria, on the basis of different criteria.	Draws sketches of bacteria; tabulates the differences between viruses and bacteria, viral diseases and bacterial diseases in man and plant.
1.9	Characteristics (only shape) and useful effects of bacteria (decomposition, manures, sewage, fixation of nitrogen-supplying B-Complex)	Recalls the parts of a bacterium. Recalls uses of bacteria.	Prepares a chart outlining different types of bacteria and their uses.
1.10	Fungi - characteristics of fungi - diseases caused by them	Recalls the characteristics of fungi and diseases caused by them in plant and man.	Observes different types of fungi and lists diseases, caused by them in plant and man.
2.	Organisation of plants		
2.1	Root system, shoot system (structure and function)	Sees relationship between structure and functions of plant parts.	Does simple experiments to investigate the functions of roots, stem and leaves.
3.	Cellular organisation		
3.1	Plant growth-meristems-growth regulators	Recalls factors responsible for plant growth.	Observes the growth of root tips and shoot tips.
4.	Reproduction		
4.1	Reproduction-vegetative and sexual reproduction in plants. Natural and artificial methods of vegetative propagation in plants	Discriminates between vegetative and sexual modes of reproduction in plants.	Tries out vegetative means of propagation of plants in school garden and at home.

4.2	Fruits - classification	Classifies fruits on the development basis.	Identifies fleshy, dry dehiscent and indehiscent fruits.
4.3	Life cycle of plants	Sees the sequential stages in the development of plants.	Observing life cycles of plants and making records of different types.
4.4	Life cycle of lower plants-spirogyra, mucor	Analyses the life cycle of higher plants.	Observes life cycle of bean, radish and mango.
4.5	Life cycle in higher plants, continuation of life cycles, annual, biennial and perennial	Recalls sexual reproduction in unisexual and bisexual plants.	Observes the sexual reproduction in cucurbita and hibiscus.
4.6	Sexual reproduction in unisexual and bisexual plants	Recognises different stage of seed germination.	Observes different stages of germination in bean seed.
4.7	Growth and development in plant seeds-germination		
5.	Organisms and environment		
5.1	Agricultural practices and implements	Relates a particular implement to the work to be done in the field.	Visits a crop field and finds out all the agricultural practices and implements used. Gives suggestions for improvements.
5.2	Preparation of soil tillage and ploughing implements used - soil plank, plough level	Realises various problems of farmers in adopting agricultural practices.	Observing sowing of seeds and transplanting in a field.
5.3	Selection of seeds and sowing, transplanting (implements used, hand, seed-drill)	Recognises the importance of selecting seeds.	Visits fields, farms and nurseries and finds out weed control measures adopted by them.
5.4	Weeding (implement used) - weedicides	Recognises the significance of weeding implements, weedicides.	Observing manuring of plants, also green manuring.
5.5	Manuring-importance and source	Realises the importance of manuring.	Visits a field and finds out methods of irrigation.
5.6	Irrigation, watering, percolation of water, logging, drainage, seepage, furrow irrigation and basin irrigation.	Recalls the various methods of irrigation and their importance in agriculture.	
5.7	Crop protection - pest, pesticides	Recalls the importance of crop protection, pesticides and pest control.	Discussion with agricultural departmental officers on methods of pest control.
5.8	Harvesting and threshing (implements used - side combine)	Recognises the harvesting implements.	Visits a field and finds out harvesting practice in operation.
5.9	Storage-godowns, cold storage.	Recalls the importance of storage of seeds and grains.	Visits a grain storage godown and finds out methods used and problems encountered therein.
5.10	Conservation of natural resources, creation of awareness of conservation of natural resources.	Realises the need to find alternate sources of fuels for conserving natural resources. Participates in activities to prevent soil erosion.	Demonstrations of soil erosion by water and wind.
5.11	Non-renewable and renewable resources; conservation of water, soil erosion (water and wind) and prevention of erosion (terracing and binders)	Recognises the need for conservation of water.	Observes the methods of soil and water conservation.
5.12	Vanamahotsava and Chipko movements, social forestry and participation of schools. Wildlife sanctuaries parks and zoos.	Realises the importance of tree planting and the relationship between forest and rains.	Celebrating wildlife week. Celebrating soil fertility week.

6. Economic Biology

6.1 Uses-antibiotics, alcohol, medicines, organic acids and food bacteria, fungi.

Prepares a report of work done on antibiotics developed from fungal and bacterial sources. Preparation of curd and dough. Makes a list of algae which are useful to human beings such as food, medicines, fodder, sewage disposal, etc.,

6.2 Uses of algae.

Recalls the uses of algae.

Recalls the uses of antibiotics.

PRACTICALS

1. Micro - slides
 - a) Bacteria - coccus, bacillus
 - b) Algae - spirogyra
 - c) Fungi - mucor
2. Typical plant - structure (external)
3. Tap root system
4. Fibrous root system
5. Various stages of germination of bean seed

Contents

1. Diversity of living organisms 1
2. Organisation of plants 22
3. Cellular organisation 29
4. Reproduction 36
5. Organisms and environment 70
6. Economic Biology 93

1. Diversity of living organisms

scientific names - methods of writing species, genus, family, natural order and class - microorganisms - differentiation between micro- and macroorganisms based on size - contribution of Leeuwenhoek - viruses - bacteria - fungi.

We know how plants are classified according to their life span. Now we shall study how plants are classified according to their similarities. This grouping and naming of plants according to their similarities is called plant nomenclature.

ARTIFICIAL AND NATURAL SYSTEM OF CLASSIFICATION

In olden days, people classified plants into useful, medicinal and crop plants. Later, plants were classified into herbs, shrubs and trees, and according to their life span. Linnaeus worked out a classification based on the nature of the stamens and pistils of the flowers. Botanists began to describe plants taking into consideration as many characteristics as possible and grouped together those plants which resembled one another in a number of ways and separated those that showed no resemblances. Thus a natural system of classification was brought into existence. There are a number of natural systems of classification but one which is widely used in India is that of Bentham and Hooker.

1.1 Scientific names of plants

Names are as inevitable and important as the objects and organisms themselves as they are

useful to refer to different kinds of organisms. As for the names of plants, there are not only the technical names but there are Latin or Greek names or their derivations as well. Each plant is named differently in different languages. A peepal tree is known as 'aswatha' in Bengali, 'jari' in Gujarathi, 'aryalu' in Malayalam and 'aras' in Tamil. To avoid confusion, uniform scientific names for plants become necessary.

A scientific name consists of two parts — the generic name and the specific name. For example, the scientific name for the peepal tree is *Ficus religiosa*. This kind of naming is called the *Binomial System of Classification*, which was introduced by the Swedish biologist Carl Von Linnaeus.

In your class there may be three or four students with the same first name. Their surnames help to distinguish one student from the other. We can compare the generic name to the first name and the specific name to the surname. The generic name alone does not help in identifying a plant, because it is common to a number of species. For example, the generic name for the lady's finger and the shoe flower is *Hibiscus* because they belong to a common genus. *Hibiscus* may refer to either the lady's finger or

the shoe flower plant. Therefore, after the generic name, the specific name is added. The lady's finger is thus known as *Hibiscus esculentes*. The shoe flower is known as *Hibiscus rosa sinensis*.

Binomial names are specific and exact in meaning, and are useful in classifying plants and their relationships, thus leading to a better understanding of them.

1.2 Methods of writing species, genus, family, natural order and class

SPECIES

The basic unit of classification is the species. All the plants which resemble one another in almost all respects and which may be considered to be the descendents of common parents are said to belong to the same species, all the tomato plants of the world form one species. They all reproduce their kind, the offspring resembling the parents in all respects. Members of one species cannot breed with members of a different species. The term 'species' was first proposed by an English naturalist, John Ray, in the 17th century. The names of species should begin with small letters.

GENERA

All the species which are related to each other by some common characteristics are brought together into a larger group called genus. For example, potato (*Solanum tuberosum*), tomato (*Solanum lycopersicum*) and brinjal (*Solanum melongena*) are three species which belong to the genus *Solanum*. The concept of genus, as it is understood today, was first recognised by Brunfels and, later, Tournefort. Tournefort's concept of several genera and genus was adopted by Linnaeus with or without any modification. Tournefort is therefore considered the father of plant genera. The generic name should always start with a capital letter.

FAMILY

Many related genera are grouped together as a

family. Take for example the two genera, *Hibiscus* and *Thespesia*. Since they resemble each other in a number of characteristics, they are said to belong to a common family, *Malvaceae*. While deciding on a family name, the name of a particular genus is chosen as the basis for the family. *Lamium* is the type genus for the family *Lamiaceae*. All the family names except a few are based upon their respective type genus. The family name is suffixed by 'ceae'.

ORDER

An order includes one or more number of related families. The name of the order ends with 'ales'.

CLASS

A group of related orders form a class.

DIVISION

Certain classes together form a division. These divisions come under plant kingdom.

NAMING FAMILIES, GENERA AND SPECIES

A family may be named after some important genus included in it, e.g., *Malvaceae* after the genus *Malva*.

Family name may be derived from some characteristic features exhibited by the plants belonging to it, e.g., *Cruciferae* because of the cruciform corolla of its plants.

A genus is generally named either after some famous botanist or some peculiar structure or habit, e.g., *Adansonia* (Adanson, a botanist) *Bauhinia* (Bauhin, a botanist) *Convolvulus* (convolute corolla).

A species name is derived in various ways. A species may be named after its discoverer, e.g., *Crotalaria Fysonii*, or after some eminent botanist, e.g., *Oenothera lamarkiana*.

The species may refer to the country where it was found originally or to some particular place in a country, e.g., *Agave americana*, *Bombax Malabaricum*.

It is usual to put the name of the person who

first described it, either after the genus or the species, in an abbreviated form, e.g., *Cassia*, (Bentham).

CLASSIFICATION OF SOME PLANTS

DICOTYLEDONAE

Common name	Kingdom	Division	Class	Order	Family	Genus	Species
Pea	Plant	Spermatophyta	Dicotyledonae	Rosales	Fabaceae	Pisum	sativum
Shoe Flower	"	"	"	Malvales	Malvaceae	Hibiscus	rosa sinensis
Sun Flower	"	"	"	Asterales	Asteraceae	Helianthus	ann
Potato	"	"	"	Polymoniales	Solanaceae	Solanum	tuberosum

MONOCOTYLEDONAE

Common name	Kingdom	Division	Class	Series	Family	Genus	Species
Banana	"	"	Plonocoty- ledonae	Epigynae	Musaceae	Musa	paradisiaca
Coconut	"	"	"	Calycinae	Arecaceae	cocos	nucifera

Activity 1: Try and classify some more plants according to the Table given. Refer to the botany books in your school library.

Activity 2: Go to your school garden and take down the common names of the plants and trees there. Get their binomial names from the botany books in the library. Prepare name boards and fix them to the trees and plants in the garden.

1.3 Microorganisms

What are microorganisms? A dictionary defines it like this:

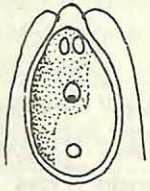
'... a very minute organism; a microorganism; a germ; popularly applied to bacteria, especially to the pathogenic forms.' This definition is an arbitrary description of these living organisms.

In order to arrive at a more acceptable definition, let us consider microorganisms as all those living organisms whose external structures can be discerned only through the microscope. These include bacteria, and blue-green algae, other algae, protozoa and certain fungi. Though

viruses are also considered to be microorganisms, it is better to study them as a separate group because they possess features of both the animate and the inanimate.

Where do microorganisms fit among earth's other living things? Living organisms are usually separated into the animal kingdom and the plant kingdom. Microorganisms may show characteristics of both plants and animals. For this reason, biologists have placed the microorganisms in a separate kingdom called Protista. Microorganisms can be also called microbes.

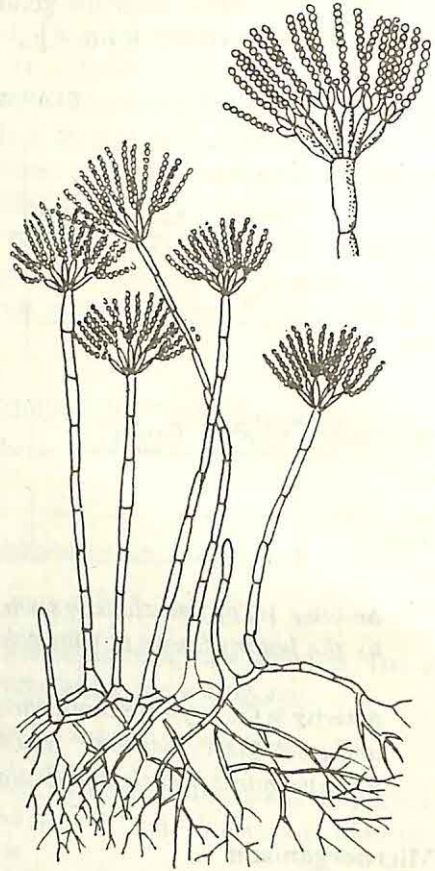
Activity 3: Take a drop of pond water and place it on a clean slide. Place a coverslip on it. Examine the material under the microscope. Look for following: 1. Abundance of organisms (Count the number of living organisms.); 2. motility (Compute the proportion of organisms that are motile and compare it with non-motile form); and 3. shapes of organisms (Observe the different shapes of the organisms and draw them in your notebooks).



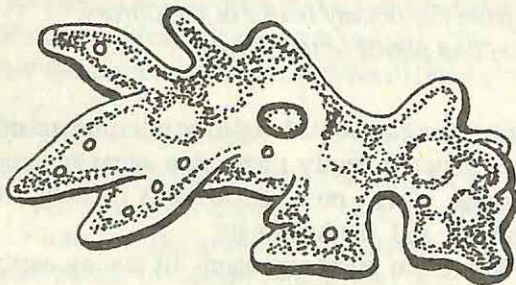
(a) Chlamydomonas



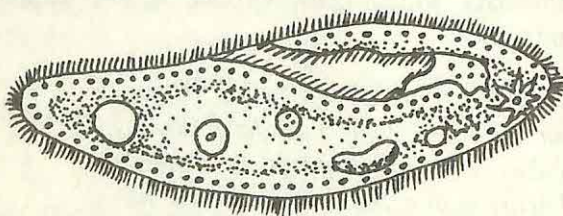
(b) Spirogyra



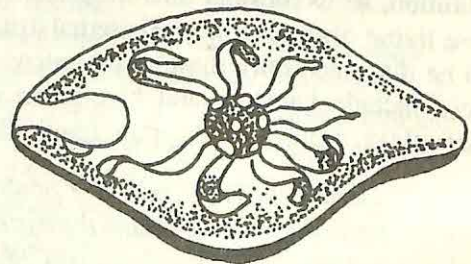
(c) Penicillium



(d) Amoeba



(e) Paramecium



(f) Euglena

Fig. 1.1 Some microorganisms.

The study of microorganisms is necessary because microbes have great importance to man and to other living organisms.

There is hardly any aspect of our lives, food, shelter or health, that is not directly or indirectly affected by microbes. Microbes play a major role in the production of cheese, beverages, antibiotics, industrial chemicals, etc. On the other hand, microbes are also the cause of some serious diseases that affect man. Microbes bring about rot in buildings and food. Whether these small organisms help man or hinder him, they cannot be ignored and therefore must be understood.

Another reason for studying microbes is their great value in science. It takes only hours to complete a full generation in the life of a microbe. This means that their life history can be studied in a short time, a factor which is invaluable to scientists and researchers. Moreover, the large number of microbes that can be handled conveniently makes experiments more precise.

1.4 Differentiation between micro- and macroorganisms

If you look around, you will notice a great diversity of living things in the world. Certain organisms such as bacteria and *Chlamydomonas* are unicellular, and their single cell is capable of carrying out all vital activities like respiration, movement, digestion and reproduction. These organisms are small and can be viewed only through the microscope and are called *microorganisms*.

While some are microscopic, there are some organisms which are large enough to be seen easily with the unaided eye. These organisms are called *macroorganisms*.

The dimensions of the cells of microorganisms are usually measured in *micrometres*. Macroorganisms are measured in millimetres, centimetres and metres, as most of them are multicellular.

Most of the microorganisms cause diseases in man, animals and plants whereas only a few of the macroorganisms cause diseases.

Microorganisms are useful in industries while macroorganisms are not. The presence of both micro- and macroorganisms is, however, essential for life on earth to carry on smoothly.

1.5 Contribution of Leeuwenhoek

For centuries, living things had been divided by a 'common sense' division into plants and animals. This classification, however proved unsatisfactory when, three hundred years ago, Leeuwenhoek, a Dutchman, discovered the hitherto unknown world of microorganisms under his simple microscope. After the invention of the compound microscope by Hook, an Englishman, in 1820, scientists began to explore the world of microbes with great enthusiasm.

BIOGRAPHY OF ANTONY VON LEEUWENHOEK

Antony von Leeuwenhoek (1632-1723) was a merchant and had no formal training in the university. There were no 'professional scientists' then as we have today, and only those who had the special interest pursued science as a private occupation and not for earning a living. With great care, Leeuwenhoek ground glasses and made simple microscopes by mounting them between two small metal plates. Objects could be magnified 300 times their original diameter. Leeuwenhoek's microscopes were not for sale but for studying any minute object that fascinated him. 'Dear God, what marvels there are in so small a creature,' said Leeuwenhoek.

1.6 Virus

Viruses are *ultramicroscopic*, *obligate parasites* which can multiply only in living cells. Viruses are smaller than the smallest bacteria. They affect a wide variety of plants and animals and cause various types of diseases, and are responsible for severe economic loss.



Fig. 1.2 Anthony van Leeuwenhoek

1.7 Occurrence, discoveries, properties and diseases caused by viruses

DISCOVERY

In the year 1892, Iwanowski discovered the causative agent of *Tobacco mosaic disease*. He infected the healthy plants with the disease. He discovered that the juice extracted from these tobacco plants contained infectious agents. He tried to remove them by filtration but he could not manage to do it even with the finest bacterial filters. He then concluded that the agent had to be smaller than any type of bacterium then known. His discovery passed almost unnoticed. Later, M.W. Beijerinck confirmed the work of Iwanowski. Dr Stanley isolated the TMV (Tobacco mosaic virus) from infected plants in the form of crystals for which he was awarded the Nobel prize. The discovery of the *electron microscope* enabled scientists to look at the viruses with greater clarity. So far about 200 viruses have been discovered and placed on record.

DEFINITION

Viruses are extremely small organisms consisting of a *nucleic acid* core surrounded by a protein layer. They cannot exist freely in nature but can only live inside some other living cell. Once inside the cells of the host, they take over completely and produce more virus cells. The individual whose body the virus has invaded suffers from the disease.

Viruses cause diseases like chicken pox, poliomyelitis, small pox, mumps, common cold, influenza, rabies, measles, etc.

SHAPE AND SIZE

The shape and size of viruses vary from species to species. The following are the different shapes of viruses.

1. Brick-shaped — Chicken pox virus
2. Rod-shaped — Tobacco mosaic virus
3. Spherical — Influenza virus
4. Tadpole-like — Bacteriophage
5. Polyhedral — Adenovirus

The elongated viruses are upto 1,200 or more millimicrons long and 10 or more millimicrons wide. The diameter of the spherical viruses varies from 17—60 millimicrons.

STRUCTURE

All viruses have the same composition — an outer protein coat called *capsid* surrounding a central core of *nucleic acid*. Each capsid consists of a number of identical protein sub-units packed together in a symmetrical pattern. An intact virus unit is called the *virion*. The capsid protects the nucleic acid core against attack by *nuclease enzymes*.

PROPERTIES

1. Viruses can be transmitted from infected plants to healthy plants.
2. A small fraction of a virus can bring about infection.
3. Viruses can be destroyed by high temperature, poisonous substances, etc.

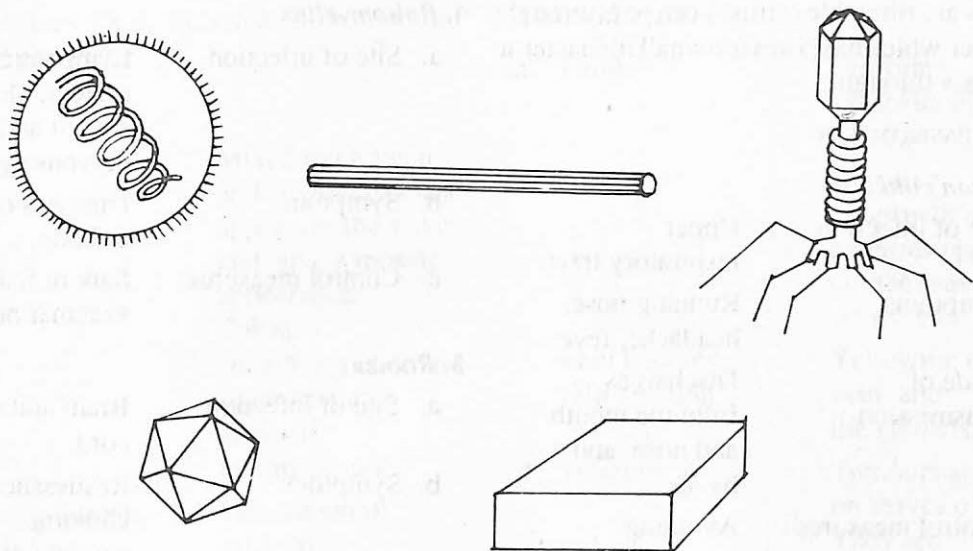


Fig. 1.3 Shapes of viruses

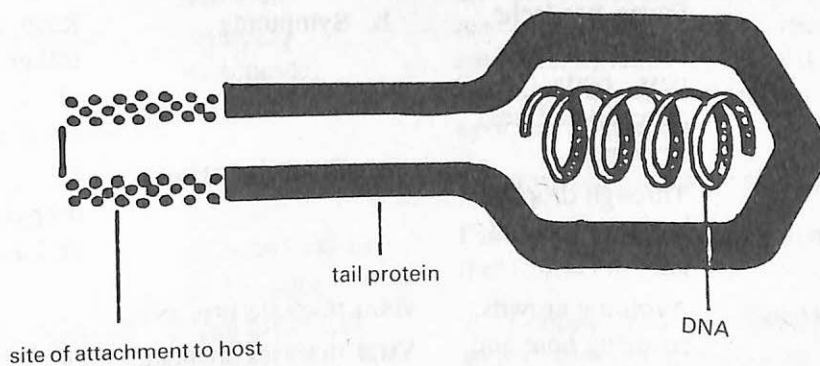


Fig. 1.4 Structure of a virus

4. They are filterable (viruses can pass through a filter which has pores too small for bacteria to pass through).

VIRAL DISEASES IN MAN

1. *Common cold* :

- a. Site of infection : Upper respiratory tract.
- b. Symptoms : Running nose, headache, fever.
- c. Mode of transmission : Discharges from the mouth and nose, and by air.
- d. Control measures : Avoiding crowded places, covering nose and mouth when coughing.

2. *Small pox* : (now eradicated)

- a. Site of infection : Whole body.
- b. Symptoms : Pustules all over the body with high fever.
- c. Mode of transmission : Air.
- d. Control measures : Vaccination.

3. *Influenza* :

- a. Site of infection : Respiratory tract.
- b. Symptoms : Fever, headache, fatigue, drowsiness, body ache, sometimes dry cough.
- c. Mode of transmission : Through droplets and fomites, and air.
- d. Control measures : Avoiding crowds, covering nose and mouth when coughing or sneezing.

4. *Poliomyelitis* :

- a. Site of infection : Lymphatic system, blood-stream and nervous system.
- b. Symptom : Paralysis of limbs or body.
- c. Control measures : Salk or Sabin vaccination.

5. *Rabies* :

- a. Site of infection : Brain and spinal cord.
- b. Symptom : Restlessness, choking, convulsion and inability to swallow.
- c. Control measures : Course of antirabies vaccination.

6. *Mumps* :

- a. Site of infection : Salivary gland.
- b. Symptoms : Swelling of salivary gland and high fever. In males, testis may be affected.

7. *Measles* :

- a. Site of infection : Skin.
- b. Symptoms : Rash, fever, inflammation of mucus membrane.
- c. Control measures : Vaccination (oral drops) for children.

VIRAL DISEASES IN PLANTS

Viral diseases in plants may be *systemic*, i.e., spread throughout the host plant, or *local*, i.e., restricted to certain areas. The symptoms appear

mostly on leaves. Death of tissues is rare in viral diseases of plants.

1. *Mosaic* :

- a. Symptoms : Mixed light green and yellow patches appear on the leaves and give a mosaic appearance. Tobacco, cucurbita, potato and sugarcane are affected by this disease.
- b. Control measures : Cultivation of tobacco on soils free from the disease, avoiding contact transmission through smoking or implements.

2. *Leaf roll* :

- a. Symptoms : Leaves of the plants curl up, e.g., in papaya, tomato and potato.
- b. Mode of transmission : Insect vectors, e.g., *Myzus persicae*.
- c. Control measures : Spraying insecticide.

3. *Bunchy top of banana* :

- a. Symptom : The leaves form a densely crowded rosette at the apex.
- b. Control measures : Uprooting and burning of diseased plants.

4. *Other diseases* :

- a. Yellowing : Uniform *chlorosis* of the leaves.
- b. Enation : Hair-like outgrowth called *enations* appear on the leaves, stems, etc.
- c. Vein banding, vein clearing : Yellowing of the vein and the veinlets.
- d. Tumours : Tumours appear on leaves or roots. They are produced by uncontrolled division and growth of cells.
- e. Stunted growth : General retardation of growth results in stunting of plants.

GENERAL SYMPTOMS OF VIRAL DISEASES IN PLANTS

Plants attacked by viruses show a number of *symptoms* or signs. Some plants die and others tolerate the infection, in varying degrees. If the whole plant is involved, the manifestation is called *systemic*. If only some regions of the plant are involved, it is said to be *primary*. Local lesions, clearing of veins, local spots, etc. are some of the primary symptoms. Mosaic mottling, ring spotting, distortion, etc. are some of the systemic symptoms.

TRANSMISSION OF VIRUSES IN PLANTS

Plant viruses spread in nature through any one of the following methods:

1. *Transmission through seeds*: Some viruses spread through the seeds of the host, e.g., beet sugar virus, legume virus.

Activity 4: With the help of your teacher or parents locate a virus infected plant in a field, garden or farm. Uproot it and gently rub its leaves with those of a healthy plant. Record your observations and interpret your result.

Activity 5: Prepare a chart with the following headings for viral diseases in plants and man:

1. Name of the disease
2. Site of infection
3. Symptoms
4. Mode of transmission
5. Control measures

2. Transmission through insects: Many viruses are transmitted through insects. The insects which carry the viruses are called vectors. Aphids, grasshoppers and mealy bugs are some of the efficient insect vectors.

3. Transmission through soil: Some are transmitted through the soil, e.g., wheat mosaic virus, potato mosaic virus, etc.

4. Transmission through mechanical means: This happens during the removal of plant sap from a diseased plant and transfer to a healthy plant, e.g., tobacco mosaic virus. Some viruses are transmitted through the agricultural tools used in the field.

5. Transmission through grafting: Viruses are transmitted by grafting diseased plants on healthy ones, e.g., witch's broom of potato. Viruses are also transmitted by fungi, nematodes, parasitic plants, pollen grains, rhizomes, bulbs, stem tubers, etc.

CONTROL METHODS OF PLANT VIRUSES

These are as follows:

1. destroying insect vectors;
2. use of disease-resistant varieties;
3. prolonged drying and high temperature;
4. use of chemicals such as Catechol, Quinol, Phenol, etc.;
5. heat treatment; and
6. selecting disease-free seeds.

1.8 Bacteria

Bacteria represent a large group of typically unicellular microorganisms which are difficult to classify as plants or animals.

Bacteria occur in stagnant ponds and ditches, running streams and rivers, hot springs, sea water, soil, air, food, garbage and manure heaps, decaying organic matter of all types, on body surface, in body cavities and in the internal tracts of man and animals.

DIFFERENCES BETWEEN BACTERIA AND VIRUSES

Bacteria	Viruses
1. Bacteria have two kinds of nucleic acid.	Viruses have only one kind nucleic acid (either DNA or RNA). These are absent.
2. Ribosomes and enzymes to generate ATP molecules are present.	
3. There are cytoplasmic organelles.	These are not present in viruses.
4. Bacteria have cell walls.	Viruses do not have cell walls.
5. Bacteria can exist anywhere.	Viruses can live only inside a host cell.
6. These can synthesise proteins.	Viruses cannot.
7. Bacteria are microscopic. The bacterial cell measures 0.2-1 micron in dimension.	Viruses are much smaller. They are ultra-microscopic. Elongated viruses measure 1200 or more millimicrons long and 10 or more millimicrons wide; the spherical ones measure 17-60 in diameter.

STRUCTURE OF BACTERIAL CELL

Except for the shape, the structure and organisation of a bacterial cell are identical in all types of bacteria. The cells may be flagellate or non-flagellate. The bacterial cell possesses a cell wall which is surrounded by a thin slimy layer. Inside the cell wall and pressing against it, is a thin cytoplasmic membrane. This membrane encloses the cytoplasm. The cytoplasm contains granules and vacuoles, and sometimes fat globules and pigment - bearing bodies. There are DNA-rich granules commonly called *chromatin granules* or *chromatin bodies* forming the nuclear material. The nuclear material is not covered by nuclear membrane. This type of cellular organisation is considered to be 'prokaryotic'. The cytoplasm does not contain *endoplasmic reticulum*, *golgi apparatus* and *mitochondria*.

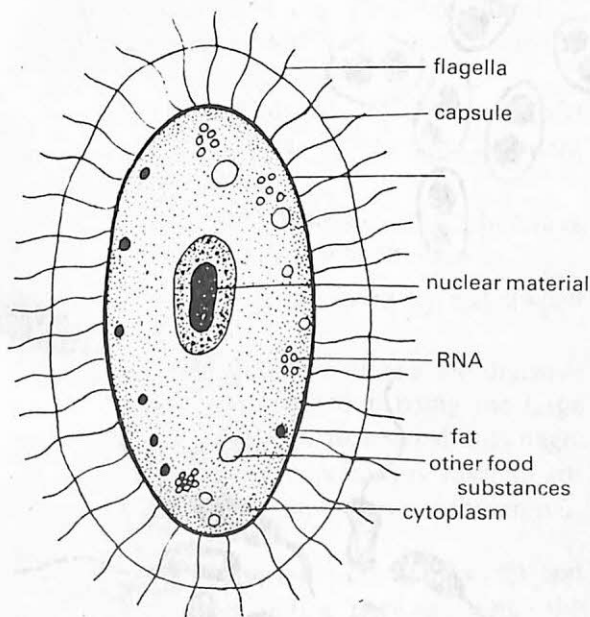


Fig. 1.5 Bacterial cell

BACTERIAL DISEASES IN MAN

Tuberculosis: This disease is caused by *Mycobacterium tuberculosis*. These bacteria are present in dirty places. The disease may spread

from an infected person or cow. The bacteria from the cow attack children. The bones and joints of the hip or spine and glands in the neck are the areas which are mainly attacked by these bacteria. Infection from the human source spreads by means of discharges from the air passages of infected persons, especially through the spectrum. The tubercle bacteria can attack any part of the body but they usually attack the lungs.

Symptoms: Persistent cough with mucus discharge.

Prevention: The patient must be isolated. All utensils used by the patient should be cleaned separately. Balanced diet, adequate sleep and fresh air can prevent this disease to a certain extent. Everyone must blow his nose into a handkerchief and spit into spittoons. Methods of diagnosis such as x-rays and skin tests can detect this disease at an early stage. Children are given B.C.G. vaccine to get immunity against this disease.

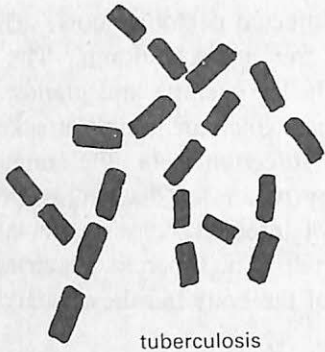
Typhoid: This is caused by short, rod-shaped bacteria with numerous flagellae.

Symptoms: Continuous fever, inflammation and ulceration of the intestine, enlargement of the spleen and characteristic 'rose spot' eruptions on the abdomen and diarrhoea or constipation are the symptoms of this disease.

Transmission: Transmission is through food and water contaminated with the germ or through personal contact with patients and carriers. Flies are also important transmitting agents of this disease.

Prevention: The patients should be isolated and their personal possessions should be disinfected. Inoculation against typhoid is possible.

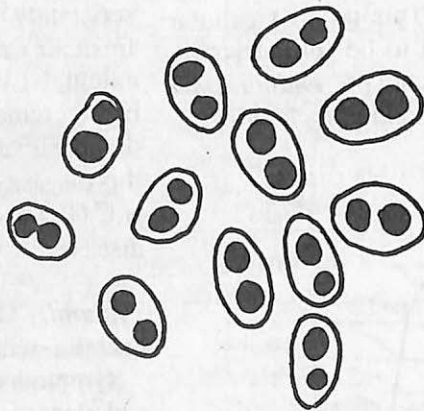
Pneumonia: This is caused by a bacterium called *Pneumococcus*. The bacteria inhabit the upper respiratory tract of man. They may also be found in the lungs.



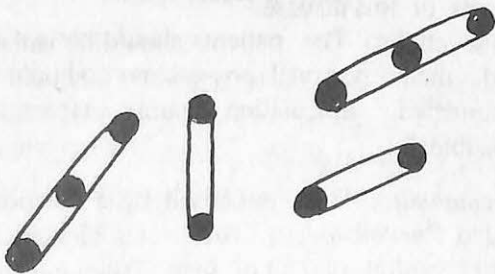
tuberculosis



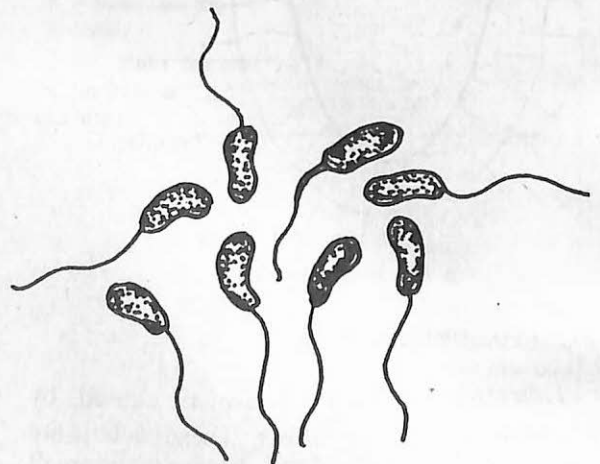
bacillary dysentery



pneumonia



diphtheria



cholera

Fig. 1.6 Bacterial cells

Symptoms: Severe chill followed by a steep rise in temperature. The inflammation in the lungs blocks air passage, thus cutting off the oxygen supply to the body.

Transmission: Transmission takes place through droplets or through *fomites*.

Prevention: Prevention of the disease may be accomplished by isolation of the patient and by avoiding contact with him. Handkerchiefs and other articles soiled with oral and nasal discharges from the patient must be disinfected. Disinfectants are substances such as phenol that can kill the germs.

Cholera: It is caused by a curved, comma-shaped bacterium called *Vibrio cholera* with a single flagellum.

Symptoms: The digestive tract is mainly affected by this disease which is characterised by profuse diarrhoea and persistent vomiting which leads to loss of body fluids, and eventually to death by dehydration.

Transmission: Polluted water and food transmit the disease. Flies are important contaminating agents.

Prevention: Immunisation against cholera is the most effective way to prevent cholera.

Bacillary dysentery: It is caused by rod-shaped bacteria.

Symptoms: This disease infects the digestive tract, the main site of infection being the large intestine where it may cause extensive damage. As a result, mucus and blood may be discharged in the stools. It also causes severe abdominal pain.

Transmission: Transmission is by water and food contaminated with the germ from the stools of patients. Flies may act as contaminating agents.

Prevention: The disease can be prevented by ensuring fresh protected water, clean food and good sanitary facilities and by controlling flies.

Diphtheria: It is caused by a straight or slightly curved, rod-shaped bacterium with swollen ends.

Symptoms: Formation of patches of false membranes in the throat and trachea is the main symptom of this disease. Obstruction of the air passage may result in death by suffocation. The toxins produced by these bacteria may cause damage to the nervous system and the kidneys.

Transmission: Transmission is through droplets sprayed from the mouth and nose during talking, sneezing and coughing. The disease may also spread through *fomites*.

Prevention: Isolation of the patient and disinfection of the articles used by him are effective in the control of the disease. Prevention is also possible through immunisation.

Tetanus: This is caused by the bacteria *Clostridium tetani*.

Symptoms: Tetanus results from the infection of a wound or raw surface with these bacteria. The toxin produced by these bacteria causes muscle rigidity and spasms. The spasms develop in the muscles of the head and neck and then spread downwards. Lockjaw causes the jaws to stiffen.

Prevention: Active immunisation is the best preventive measure. A dose of tetanus toxoid enables the individual to develop antitoxins against the injected toxin, and immunity against infection.

BACTERIAL DISEASES IN PLANTS

Species of all major families of higher plants are known to be attacked by one or more bacterial pathogens. Some of the symptoms developed by bacterial pathogens are *wilting, blight, leaf spot, canker* and *gall*.

1. Citrus canker: This is caused by *Xanthomonas citri*.

Symptoms: Lesions consisting of depressions with raised margins are called cankers. Cankers appear on all parts of the citrus plants. First, raised pustules are formed, which rupture and depressions appear at these places, yellow hollows surround the cankers on the leaves but not on

fruits. In cases of severe infections, the leaves fall off causing defoliation of the plant. Infected twigs dry up.

Control:

1. Diseased plants should be removed and burnt as soon as detected.
2. Fungicides like Bordeaux mixture and Bordeaux oil emulsion control the disease.
3. Antibiotics like streptomycin sulfate, Phytomycin and Agrimycin 100 also control the disease.

2. *Bacterial Wilt of tomato*: This is caused by

Pseudomonas solanacearum.

Symptoms : The most important symptom is the drooping of the leaves, petioles and branches. The other important symptom is the browning of the vascular tissues. Vein clearing, chlorosis of leaves, defoliation and stunting of growth also accompany wilting and browning.

1.9 Characteristics

Based on their shape, bacteria are classified into the following groups: 1. cocci, 2. bacilli, 3. vibrio, and 4. spirillum.

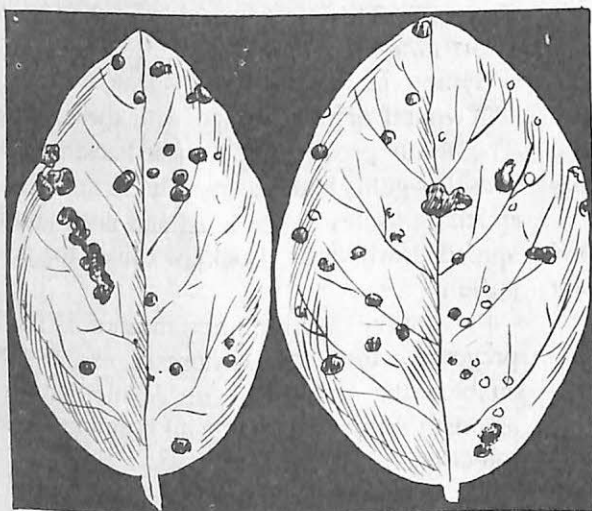


Fig. 1.7 Citrus canker symptoms on leaves

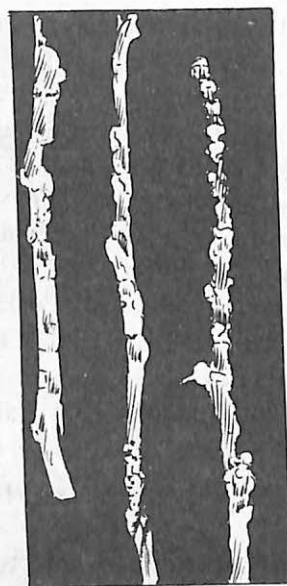


Fig. 1.8 Citrus canker symptoms on stems

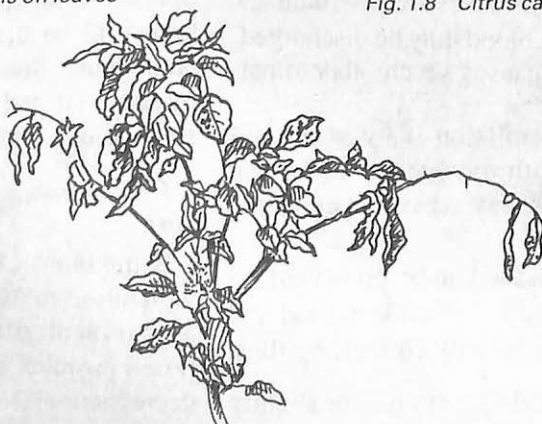


Fig. 1.9 Wilt disease of tomato

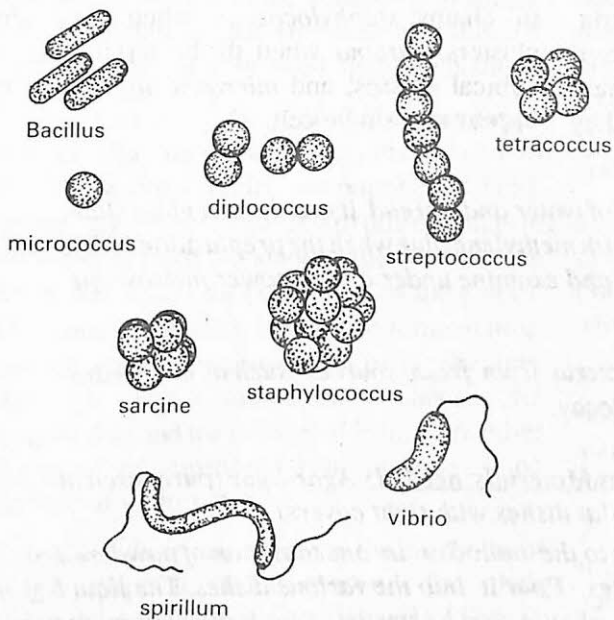


Fig. 1.10 Cocci and bacilli

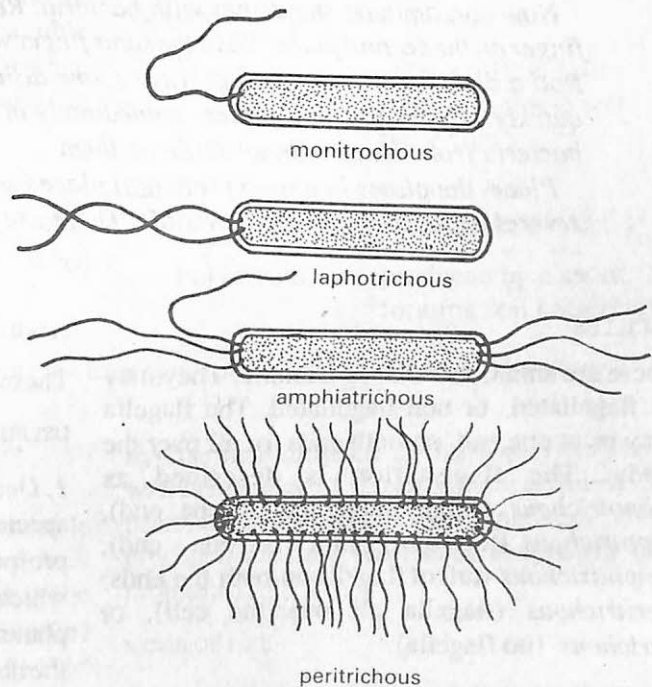


Fig. 1.11 Flagellation in bacteria

COCCI

They are small, spherical or nearly oval bacteria. Cocci are classified into several groups based mainly on the manner in which they remain together after dividing: *diplococcus* when they

occur in pairs; *streptococcus* when they adhere in chains; *staphylococcus* when they are in clusters; *sarcina* when the bacterial cells form cubical masses; and *micrococcus* when they appear as a single cell.

Activity 6: Mix a little curd in a drop of water and spread it evenly on a glass slide, warm it over a low flame and stain with methylene blue when the preparation is dry. Rinse it gently with tap water. Dry and examine under a high power microscope. Can you see the bacteria?

Activity 7: Examine the forms of bacteria from fresh sources (such as hay, beans, flies) which have been allowed to decay.

Activity 8: Growing bacterial cultures. Materials needed: Agar-agar (purchased at a chemist's shop), boiling water, flat dishes with tight covers.

Method: Bring half a cup of water to the boil. Stir in one teaspoon of powdered agar-agar and boil for fifteen minutes. Pour it into the various dishes. The liquid will harden as it cools. (The dishes should first be sterilized by boiling them for fifteen minutes. Everything used, including the measuring spoon, should be boiled.)

Now contaminate the dishes with bacteria. Roll a pencil over one. Rub a dirty finger on the second plate. Wash the same finger with soap and water over the other. Roll a dirty fork over another. Leave one dish untouched as a control. Cover it quickly. Cover all the plates immediately after contaminating them so that bacteria from the air cannot settle on them.

Place the plates in a warm (not hot) place for two days. At the end of this time several white spots should be visible. These are colonies of bacteria.

BACILLUS

These are small, rod-shaped bacteria. They may be flagellated or non-flagellated. The flagella may be at one end, on both ends or all over the body. The flagellation is described as *monotrichous* (single flagellum at one end), *lopotrichous* (tuft of flagella on one end), *amphitrichous* (tuft of flagella on both the ends) *peritrichous* (flagella all over the cell), or *atrichous* (no flagella).

VIBRIO

These are short, curved, comma-shaped flagellated and monotrichous.

SPIRILLUM

These are spirally, twisted bacteria.

USEFUL EFFECTS OF BACTERIA

1. Decay and decomposition: Many saprophytic species of bacteria are capable of producing profound chemical changes in the substrate on which they grow. Decay and decomposition of plants and animals is of this type. Decay includes the decomposition of organic bodies into simpler substances as water, carbon dioxide, ammonia and hydrogen sulphide. The processes of decay are important to man for at least two reasons.

They prevent the accumulation of organic matter and they result in the formation of simple compounds, thus setting free elements that are returned to the soil to be used again by plants.

2. *Fermentation*: Many of the fermentation processes that are carried on by bacteria are of domestic or commercial importance. Thus, species of *Azotobacter* produce acetic acid (vinegar) from the alcohol formed from the juice of ripe fruits, especially apples and grapes.

The souring of milk is another fermentation process that involves conversion of lactose into lactic acid. The manufacture of cheeses, the retting of flax and the tanning of leather are other examples of fermentation processes of commercial importance.

3. *Sewage disposal*: Most of the methods of sewage disposal are dependent for their efficiency on the activities of bacteria. This is true of methods involving the use of septic tanks and cesspools. Certain bacteria rapidly break down the solid organic materials into soluble compounds. The use of sand filters for sewage disposal involves the action of many aerobic bacteria.

4. *Fixation of nitrogen*: There are certain bacteria which are capable of fixing the atmospheric nitrogen directly into the soil. These are called

nitrogen fixing bacteria. One type of these bacteria lives independently in the soil. Two important genera of this group are *Azotobacter* and *Clostridium*. The other type *Rhizobium* lives in the root nodules of leguminous plants. Both these groups tend to increase the nitrogen content in the soil.

5. *Manuring*: The bacteria that bring about decomposition of cellulose and similar compounds are important in the production of humus. The humus later forms manure for the plants.

6. *Supplying B-complex*: Vitamin B₂ is obtained by the fermentation of sugars and starches brought about by the action of *Clostridium* and *Acetobutylicum*.

7. *Antibiotics*: The bacteria play an important role in the production of *antibiotics*. These are substances that have capacity to inhibit the growth of other microorganisms and to destroy them. The following are the important antibiotics obtained from bacteria:

Tyrothricin	—	obtained from spore forming aerobic soil bacterium
Bacitracin	—	isolated from contaminated wound
Polymycin	—	produced by a spore forming soil bacterium

Activity 9: Prepare a chart showing the uses of bacteria, with pictures and drawings.

1.10 Fungi—characteristics of fungi, diseases caused by them

Fungi are *eukaryotic* organisms, which resemble plants in that they have cell walls. Fungi lack chlorophyll, hence they are heterotrophic. The body of the fungus is composed of numerous delicate filaments known as *hyphae*. The hyphae of the fungus is collectively called mycelium. Mycelium is the plant body of the fungus. Hyphae can be septate or non-septate. Non-septate

hyphae are multinucleate or *coenocytic*. The cell wall is made up of *chitin* and not cellulose. The protoplasm is granular. Food particles, chiefly glycogen and lipid substances, are present in the protoplasm.

MODE OF LIFE

Fungi get their food from other living organisms or from organic remains — dead animals and plants. Those developing on living animals or

plants are called *parasites* and those which develop on dead organic matter are called *saprophytes*. Fungal hyphae produce certain special sucking structures called *haustoria* which help in absorbing nourishment. All fungi secrete special enzymes with the help of which they absorb and digest food materials.

REPRODUCTION

Sexual reproduction is seen only in the less advanced forms. In advanced forms, asexual reproduction is brought about by the production of various kinds of spores. In some of the lower fungi, ciliated *zoospores* are produced. In more advanced forms the asexual spores are produced inside sac-like structures called *sporangia*. Sporangia are found at the end of the vertical hyphae. The spores, known as *sporangiospores*, are non-motile and are disseminated by the wind. In certain cases, a series of spores are

pinched off from the ends of the hyphae in regular succession, so that the spores are found in chain. These spores are called *conidiospores*. All these spores, following germination, produce hyphae which branch profusely. The branches get matted together and a mycelium is produced.

DISEASES CAUSED BY FUNGI

A few fungi attack human beings and cause a lot of discomfort. Ringworm, who's itchy and some foot diseases are caused by fungi. Some of the skin diseases are also caused by fungi.

Fungi cause diseases in plants as well as in animals and human beings. They are sometimes responsible for considerable damage and destruction of crops. Some of the common plant diseases are the leaf spot disease, the damping off, the downy mildews, ergot of rye, smuts, rusts, wilt and red rot of sugarcane.

Activity 10: You can grow Rhizopus by keeping moist bread under a bell jar for 4-5 days. Place a little bit of the mould in a drop of water on a glass slide. The branched hyphae lack partitions. The cytoplasm can be seen constantly streaming in all directions. Recognize droplets of oil and numerous nuclei after staining with cotton blue.

Some basic concepts

1. The scientific names of plants are called binomial names.
2. A binomial name consists of two words — the genus name and the species name.
3. Names of families end with 'aceae', and names of order end with 'ales'.
4. Binomial names help to avoid confusion, and are very useful in research work.
5. Microorganisms are organisms which can be seen only with the help of a microscope.
6. Microorganisms occur everywhere.
7. Viruses can multiply only in a living cell.
8. Viruses are of various shapes.
9. Viruses cause diseases.
10. Bacteria are found everywhere.

11. They do not have a definite nucleus.
12. They have different shapes — coccus, bacillus, vibrio and spirillum.
13. Some bacteria cause diseases like tuberculosis, cholera, typhoid, pneumonia, diphtheria, tetanus and bacillary dysentery.
14. Some bacteria are beneficial.
15. Fungi do not have chlorophyll.
16. They are heterotrophic, parasitic or saprophytic.
17. The cell wall is made up of chitin.
18. Fungi cause diseases in plants as well as in human beings.

REVISION TIME

I. Fill in the blanks:

1. Organisms which can be seen through the microscope are called _____.
2. Comma-shaped bacteria are called _____.
3. The causative agent of measles is _____.
4. Nitrogen fixing bacteria are found in _____ plants.
5. Bacteria without flagellae are called _____.
6. Bacteria found in chains are called _____.
7. Fungi lack _____.
8. The cell wall of fungus is made up of _____.
9. Fungus has _____ type of nutrition.
10. Multinucleate condition of fungal hyphae is called _____.
11. Special sucking structures in fungus are called _____.
12. In advanced forms of fungus there is no _____ reproduction.

II. Do the following :

1. Give the differences between virus and bacteria.
2. Differentiate lophotrichous and peritrichous bacteria.
3. Write notes on any two bacterial diseases.

4. Draw and label the parts of a bacterial cell.
5. Differentiate between cocci and vibrios.
6. Are viruses living organism? Explain.
7. Write an essay on the characteristics of fungi.
8. Name the different types of spores produced in fungi.
9. Name the diseases caused by fungus in man and plants.

III. Answer the following :

1. Write a general account of bacteria and add a note on their economic importance.
2. Name the causative organisms of the infectious diseases you have learnt. In each case explain the mode of transmission and the preventive measures that may be adopted.
3. Name any five diseases caused by bacteria.
4. How do bacteria differ from viruses?
5. Explain binomial nomenclature.

IV. Which of the following diseases are caused by bacteria?

- | | | |
|-------------|-----------------|---------------|
| 1. measles | 2. tuberculosis | 3. jaundice |
| 4. smallpox | 5. chickenpox | 6. pneumonia. |

V. Put a cross in the box next to the correct answer:

1. Growing and naming of plants according to their similarities is called
 - a. Plant nomenclature ☐
 - b. Physiognomy ☐
 - c. Histology ☐
 - d. Agronomy ☐
2. A fungus is the causative agent of
 - a. Mumps ☐
 - b. Hookworm infestation ☐
 - c. Ringworm infestation ☐
 - d. Tapeworm infestation ☐
3. In the group of fungi
 - a. all are autotrophic. ☐
 - b. all are parasites. ☐

- c. all are saprophytes. ☐
- d. some are saprophytes and some are parasites. ☐
4. The remains of dead plants and animals are finally reduced to water and carbon dioxide by the action of:
- a. bacteria ☐
- b. sunlight ☐
- c. enzymes ☐
- d. certain juices ☐

VI. Write 'T' for true and 'F' for false statements in the boxes:

1. All bacteria are heterotrophic. ☐
2. A sphere shaped or a round bacteria is called a coccus. ☐
3. Bacterial cells are either spherical, rod-like or spiral in form. ☐
4. When a plant has a genus name and a specific name, it is called binomial classification. ☐
5. Virus is an organism which can exist by itself. ☐

2 Organisation of plants

root system - characteristics of root - functions of root - regions of root - structure of root hair cell -
shoot system - characteristics, function, types of stem.

2.1 Root system, shoot system

The plant is formed of two portions. The portion of the plant below the soil is the *root system*. The portion of the plant above the soil is the *shoot system*.

Activity 1: Take a seedling of any dicot plant and examine it. Observe the different parts of the plant.

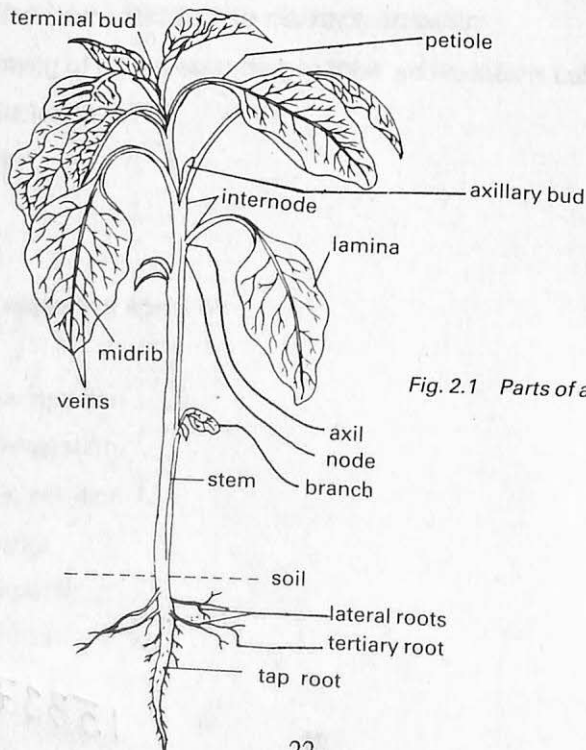


Fig. 2.1 Parts of a plant

ROOT SYSTEM

Root systems are commonly differentiated into two types — *tap root system* and *fibrous root system*. The tap root system has a central axis which is the *tap root* or *primary root*. The roots

arising from the tap root are called *secondary* or *lateral roots*. The roots arising from the secondary roots are called *tertiary roots*. There are a number of root hairs all over the roots.

Activity 2: Dig out a herbaceous plant from the garden with the roots intact. Wash the roots and observe the different parts of the roots.

Activity 3: Dig out a sapling of neem or tamarind and also dig out a grass plant or paddy plant. Wash the roots of both and compare them.

Characteristics of roots

1. They are usually below the ground.
2. They are cylindrical in shape.
3. They are brown in colour.
4. They grow towards gravity, so they are positively geotropic.
5. They grow against sunlight, so are negatively phototropic.
6. Nodes and internodes are absent.
7. The root ends in a cap-like structure known as the *root cap*.
8. The root develops from the *radicle*.
9. Lateral roots or secondary roots arise from an inner layer and are then said to be *endogenous*.

Activity 4: Take a sieve (with slightly big holes). Make three holes on its side and pass a string through them. Tie the three ends together and hang the sieve from a nail in such a way that the sieve is horizontal. Fill the sieve with saw dust. Place a few soaked seeds on the saw dust. Observe what happens after few days.

Functions of the root

1. **Fixation:** The root fixes the plant firmly to the soil.
2. **Absorption:** Roots absorb water and mineral salts from the soil.
3. **Conduction:** The root hairs on the root absorb the soil water and pass it on to the stem.

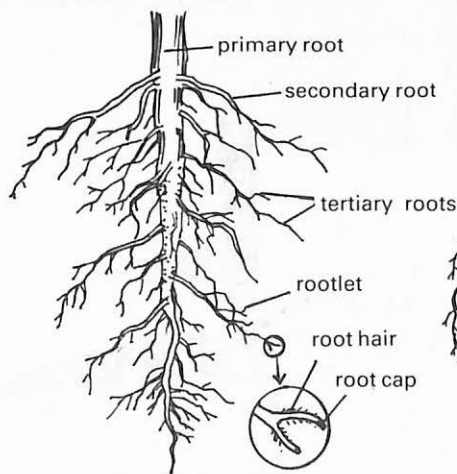


Fig. 2.2 Tap root system

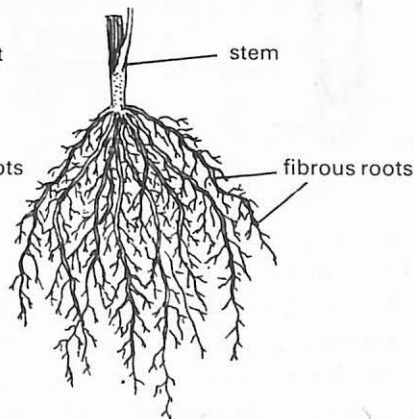


Fig. 2.3 Fibrous root system

Activity 5: Take a carrot, and scoop out a cavity on its top, about 3 – 4 centimetres deep. Fill the cavity with some sugar solution. Close it with a one-holed cork. Pass a long glass tube through it. Mark the level of sugar solution. Take a beaker of water and place the carrot in it and hold it in place with the help of a stand. Leave this for a few hours. After about 7 – 8 hours, observe the level of sugar solution in the carrot.

Activity 6: Take a well watered potted plant. Cut the stem near the soil. Observe what happens.

The regions of root: There are four distinct regions in a root. At the tip of the root is the *root cap*. This protects the growing tip. Just above the root cap is the region of *cell division*. The cells of this region undergo *division*. Above the region of cell division is the *region of*

elongation. This region shows the maximum growth. Above this region there is a zone which has the root hairs. This is the *region of root hairs*. This is the main part involved in the absorption of water. Behind the root hair lies the *mature* part of the root.

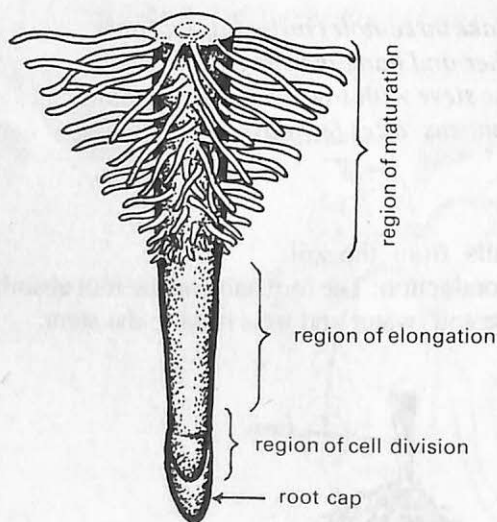


Fig. 2.4 Regions of the root

Structure of a root hair cell: The root hair is a tubular outgrowth of the epidermal cell of the root. It is covered by cellulose. It has cytoplasm inside. Embedded in the cytoplasm is the nucleus. There is a large vacuole in the centre. The wall of the root hair is mucilaginous and so it sticks to the soil particles.

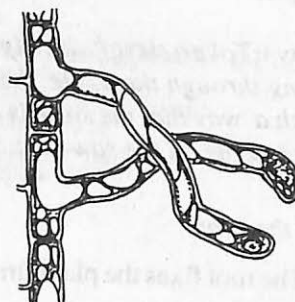


Fig. 2.5 Root hair – unicellular

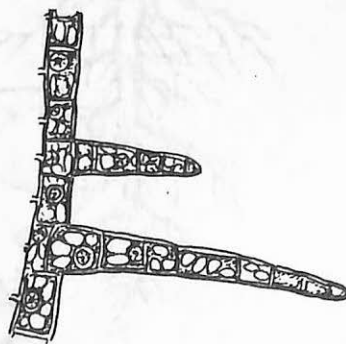


Fig. 2.6 Root hair – multicellular

Activity 7: Take a saucer or petridish. Spread a piece of cotton at the bottom. Wet the cotton. Spread some mustard seeds on it. Observe the seeds after a day or two. Take the germinated seeds with the radicle and observe them with a magnifying glass. Observe the root hair region clearly.

Activity 8: Germinate some bean seeds. When the radicles grow to a certain length take a few of them, and mark the radicles at equal intervals with red ink or marking ink.

Take a glass tumbler. Roll a piece of blotting paper and keep it in such a way that it touches the wall of the glass. Pour a little water at the bottom of the glass. Let the lower edge of the blotting paper touch the water surface. Place the seeds between the blotting paper and the wall of the glass with the radicles pointing downwards. Examine the marked part of the radicle after two days.

SHOOT SYSTEM

The main axis of the shoot system found as a continuation of the tap root is the stem. The shoot system develops from the *plumule* of a seed. The stem consists of node, internode, leaf, axil, bud, branch and flowers.

The *node* is the part of the stem from where a leaf develops. The part of the stem found between two consecutive nodes is called an *internode*. The leaf has a stalk, the *petiole*, which holds the

lamina. The angle between the petiole and the stem is the *axil*. The bud in the axil is the axillary bud which later forms the branch of the stem. Buds at the apex of the plant are known as terminal buds. The terminal bud gives rise to the flower. At times the axillary bud also forms a flower. Flowers are part of the shoot system and are important in reproduction, forming the fruits and seeds later on.

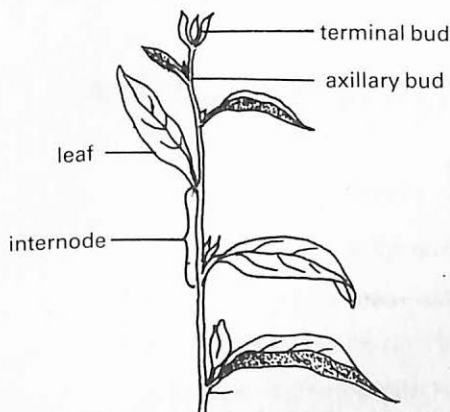


Fig. 2.7 Shoot system of an erect stem

Characteristics of the stem

1. The stem grows against gravity and is therefore negatively geotropic.
2. It grows towards sunlight and so is positively heliotropic or phototropic.
3. It has nodes and internodes.
4. It is usually green in colour.
5. Most stems are cylindrical in shape.
6. It has axillary and terminal buds. These buds may give rise to branches (vegetative buds) or flowers (floral buds).

Activity 9: Place a well watered potted plant in a room near the window. Close all the windows and the doors of the room. Close the window near which the potted plant is kept in such a way that there is only a small opening. Observe the plant after some days.

Functions of the stem

1. Conduction: Stems conduct water and dissolved mineral salts from the roots to the leaves. They also conduct prepared food from the leaves to different parts of the plant.

2. Support: The stem provides support to the branches and leaves. It holds the leaves in a position where they can effectively receive sunlight. It also holds the flowers and fruits in positions suitable for pollination and dispersal.

Activity 10: Get a balsam plant with its roots. Take a glass bottle and close its mouth with a single-holed stopper. Fill the bottle with one per cent solution of eosin or red ink solution. Fix the plant as shown in the picture. After some time, longitudinal streaks of red colour will be seen in the stem. Little later, in each leaf, the whole network of veins get the same colouration.

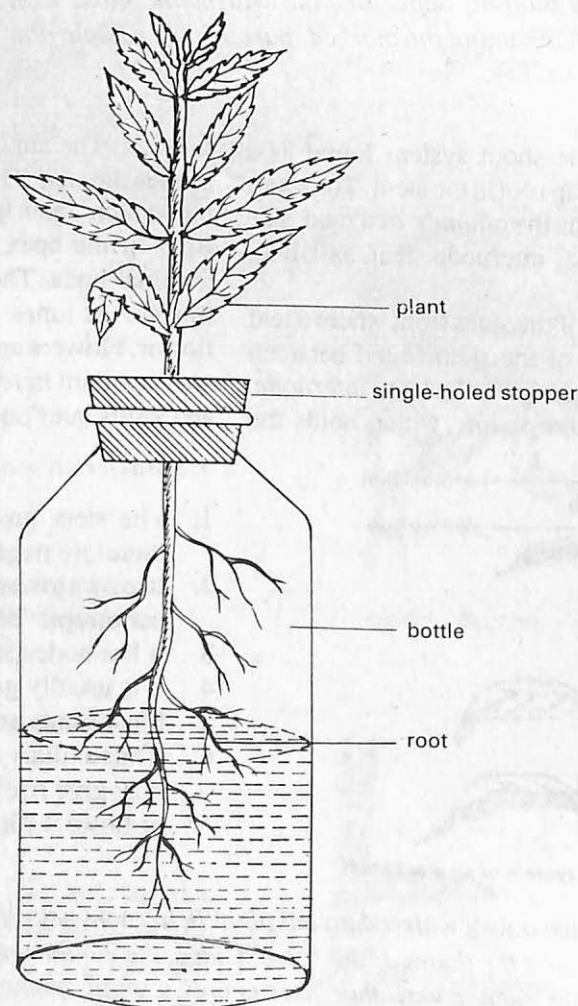


Fig. 2.8 Conduction in stem

Activity 11: Remove a strip of bark from the lower portion of the stem, in the form of a ring. After a few days observe what happens to the place from where the bark had been removed.

Types of stem: The stems of some plants may be soft and small. They are called *herbaceous stems*. Plants with herbaceous stems are *herbs*, e.g., ruellia, sunflower.

When the stems are hard and woody, they are known as *woody stems*. Plants with woody stems are trees, e.g., mango, coconut.

If the stems are short and thick, they are called *shrubby stems*. The plants with shrubby stems are *shrubs*, e.g., hibiscus, ixora.

In the majority of plants, the stem is above the ground. Such stems are called *epigeous stems*, e.g., sunflower, mango.

In some plants, parts of the stem are found

below the ground. They are known as *underground stems*, e.g., ginger, onion. Epigeous stems can be divided into *erect stems* and *weak stems*. Erect stems are strong enough to stand upright and support the branches, e.g., ocimum, rose. Weak stems are thin and weak and are unable to be erect. Weak stems which grow horizontally on the ground are called *creepers*, e.g., water melon, evolulus.

When the whole stem coils round a support, it is called a *twiner*. *Climber* is a type of stem, where any part of the stem is modified into a particular structure to climb the support, with the help of *tendrils* as in, pea, cissus, etc., *hooks* as in baubinia, and *thorns* as in zizipus.

Activity 12: Compare the stems of the following plants: sunflower plant, tridax, launea, Artabotrys odoratissimus, bougainvillea, onion, smilax, antigonon.

Some basic concepts

1. A plant has two parts — the root system and the shoot system.
2. The root system is below the ground and the shoot system is above the ground.
3. There are two types of roots — tap roots and fibrous roots.
4. The root system fixes the plant to the soil and the shoot system supports the plant.
5. The root system absorbs water from the soil and conducts it to the stem and the stem conducts it upwards.
6. The stem supports the various parts of the shoot system.

REVISION TIME

I. Fill in the blanks:

1. Roots are negatively _____.
2. Stems are negatively _____.
3. The space between two consecutive nodes is called _____.
4. Roots arising from the primary root are called _____.
5. The point on the stem from which the leaf arises is _____.

II. Questions:

1. What are the characteristics of the root system?
2. What are the characteristics of the shoot system?
3. Name the functions of the root.
4. Name the functions of the stem.
5. What is an axillary bud?
6. What are root hairs? What is their function?

III. Exercises:

1. Draw and label the parts of a plant.
2. Name three plants with tap root and three plants with fibrous root system.
3. Write an experiment to show that stem grows towards the light.

IV. Say whether the following are true or false.

1. Stems are negatively phototropic.
2. Roots develop from the radicle.
3. Epigeous stems are those which are found above the soil.
4. The neem tree has fibrous root system.
5. Terminal buds are found at the node.

3 Cellular organisation

plant growth - meristems - growth regulators.

3.1 Plant growth, meristems, growth regulators

Growth is more than a mere increase in weight and size. It involves progressive changes in the form of an organism. This feature of growth is sometimes called development.

The growth of the organs of higher plants involves not only the enlargement of cells already present but also the formation of new cells.

In the growth of a cell organ or an organism, several stages are recognised, namely, a *formative* phase, an *enlargement* phase and a *maturation* phase.

Cells that are in a formative condition are thin walled and continue to divide. In all multicellular plants, the formation of new cells takes place in the formative regions or *meristems*. The group of cells forming a meristem can be called *meristematic tissue*.

MERISTEMATIC TISSUE

The meristematic tissue consists of immature cells which are not differentiated and which are capable of cell division.

Cell-structure: The cells of this tissue are comparatively small, polygonal or cubical in shape and are compactly arranged without inter-

cellular spaces. They have dense cytoplasm with small or no vacuoles and large nuclei. The cell wall is very thin and made up of cellulose.

Depending on the position they occupy in plants, meristems are classified as *apical*, *lateral* and *intercalary meristems*.

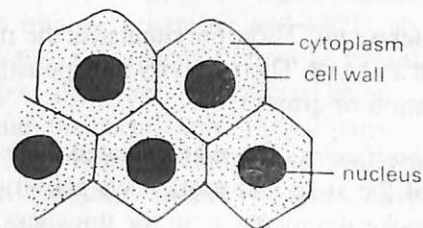


Fig. 3.1 Meristematic tissue

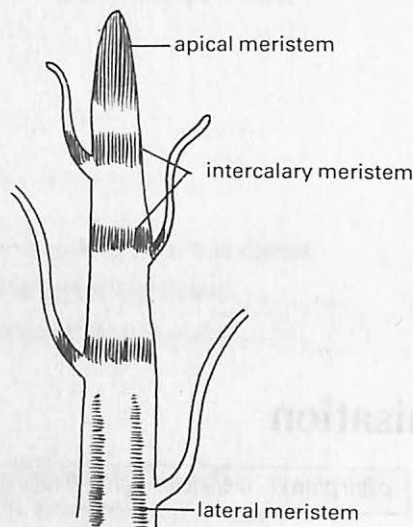


Fig. 3.2 Meristems, their position in a plant

Activity 1: Germinate a few bean seeds and when the radicles are quite long, take a few of the seedlings and mark the roots at equal intervals with Indian ink or marking ink. Take a sheet of blotting paper and roll it into cylindrical shape. Insert it into a glass tumbler. There must be some water at the bottom of the glass tumbler and the blotting paper should be touching the water. Place the seedlings with the markings between the blotting paper and the wall of the glass tumbler. The root should be facing downwards. Observe this after two days, especially the gaps between the markings just behind the tip.

1. **Apical meristems:** These are situated at the tips of the stem and root. Their activity is responsible for elongation or growth.

2. **Lateral meristems:** These are situated towards the sides of the stem and root. Their activity is responsible for the increase in the thickness of the stem and root.

3. **Intercalary meristems:** These meristems are found at the base of the internodes of the stem and the leaf base of many monocotyledonous plants. They are responsible for the elongation of the axis.

Meristems may be divided into primary and secondary meristems. The primary meristem is present from the time of its original development

in the embryo. Meristems that arise from permanent tissues are called secondary meristems.

PRIMARY AND SECONDARY GROWTH

Primary growth: Growth in plants takes place at the tips of the stem and root.

Secondary growth: Secondary growth is increase in the thickness of the stem or root. This is brought about by the *lateral meristem*. The formation of secondary tissues from the lateral meristem or cambium increases the thickness of the stem or root. This mostly occurs in dicotyledonous plants. According to variations in the climate, the activity of the cambium also varies. Growth will be maximum during spring, hence the maximum amount of secondary tissues are

formed then. These constitute the *spring wood*. During the other seasons, a small amount of secondary tissue is formed. This is called the *autumn wood*. The spring wood and autumn wood together form the *annual ring* or *growth ring*. In a cross-section of the stem, there are a number of growth rings appearing in concentric circles. By counting these rings we can find out the approximate age of the tree.

MEASUREMENT OF GROWTH

The rate of growth varies from plant to plant. To start with, the rate of growth is very slow. Then it increases until a maximum is reached, after which it declines quickly and gradually slows down until it stops. The period when the entire growth takes place is called the *grand period of growth*.

Activity 2: *The rate of growth can be measured using an apparatus called auxanometer. The auxanometer consists of an R-shaped scale. This is fixed to a stand. The scale is attached to the pulley with a long pointer.*

Tie a thread to the tip of the plant and pass it over the pulley. Tie a small weight to the other end of the thread to keep it in tension. When the plant grows, the weight pulls the thread down and this moves the pulley. This in turn, makes the pointer move on the scale.

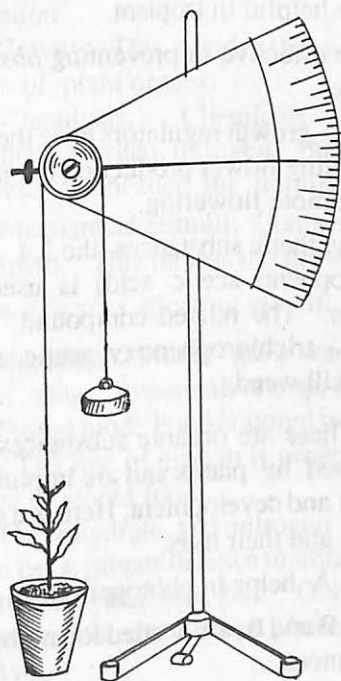


Fig. 3.3 Auxanometer

The rate of growth of the plant is determined by using the following formula:

$$\text{magnification} = \frac{\text{length of the pointer}}{\text{radius of the pulley}}$$

$$\text{actual growth} = \frac{\text{number of divisions covered by the pointer}}{\text{magnification}}$$

GROWTH REGULATORS

The factors that affect growth are heredity, the presence of growth regulating substances like hormones, vitamins and other physiologically active substances occurring in minute quantities, the general nutritional balance of the plant and the correlation of plant parts.

Hormones are substances which are produced in minute quantities and have profound physiological effects. Plant hormones or *phytohormones* play a prominent role in the metabolism and growth of the plant, influencing root and stem growth, the elongation of cells, the production of flowers, movement of organs, the dominance of certain parts of the plant over others and also the production of many abnormal growths such as galls and tumours. Many synthetic compounds such as indole butyric acid,

Activity 3: Cut 1 or 2 mm of the tip of the coleoptile of oats and observe it. Then place the tip back on the cut coleoptile and see what happens.

naphthalene, acetic acid, naphthalene acetamide and many others produce similar effects on plants. The general terms *growth regulating substances* or *growth substances* are also given to the plant hormones and vitamins.

Plant hormones: Prominent among plant growth substances are the *auxins*. They are essential for normal growth in length. They are found in the growing tips of stems, pollen, seeds, leaves and other organs of the plant. They are found in the apical meristems.

When the tip is cut the upper portion of coleoptile does not *elongate*. When the bit is replaced it elongates. If the tips of the coleoptile are cut off and placed on a agar gel, some of the growth promoting substances diffuse out of the tips into the agar. This indicates that something produced in the tip is transported downward.

Auxins can be extracted from plant tissue with chloroform or ether. One of the auxins called *heteroauxin* is indole acetic acid.

Extracts from coconuts, malt, yeast, wheat germ and other plant parts have growth promoting effects on excised embryos and other plant tissues. *Kinnins* are the substances which promote cell division.

Gibberellic acid is another growth regulator obtained from the fungus, *Gibbrella fujikuroi*.

Cytokinin: Cytokinins along with other hormones regulate growth and development in plants.

Absciscic acid: This acts as a growth retardant. It seems to cause leaf fall and induce bud dormancy.

Ethylene: The substance ethrel liberated from ethylene influences flowering, vegetative growth, maturity and ripening of fruits.

Florigen: This substance initiates floral bud formation.

Morphactin: This stimulates branching and induces bud dormancy.

Uses of growth regulators

1. Growth regulators help in stem elongation.
2. They promote cell division.
3. They initiate the formation of root in cuttings.
4. They help to prolong dormancy, induce fruiting and prevent fruit dropping.
5. They are responsible for germination of seeds.
6. They produce parthenocarpic fruits.
7. They are helpful in tropism.
8. They are effective in preventing *abscission* of leaves.
9. Generally growth regulators have the effect of inhibiting flower production but in some cases promote flowering.
10. Some synthetic substances like 2,4 -D (2,4 -dichloropheno acetic acid) is used as a herbicide. The related compound 2,4,5 -T (2,4,5 - trichlorophenoxy acetic acid) is used to kill weeds.

Vitamins: These are organic substances which are synthesised by plants and are important for their growth and development. Here are some of the vitamins and their uses.

Vitamin A helps in photoperiodism.

Vitamin B and B₂ are needed for normal root development.

Vitamin C plays a catalytic part in photophosphorylation.

Vitamin K acts as regulator of oxidation and reduction processes in a cell.

External factors affecting growth:

1. Temperature: The minimum temperature for plant growth is 5°C the maximum temperature is between $30 - 40^{\circ}\text{C}$. If the temperature increases beyond the maximum the plant dies. The best suited temperature for growth is called the *optimum temperature*. This is between $25 - 30^{\circ}\text{C}$.

2. Light : Growth is usually retarded by bright light and increased by feeble light or darkness. Light is necessary for chlorophyll formation and manufacture of food materials. Light has a marked effect on flowering and fruit formation.

3. Water: Plants need water for their growth. When there is shortage of water, plants die.

4. Oxygen: Oxygen is needed for respiration. The needed energy for growth is obtained from respiration.

5. Gravity: This decides the direction of the growth of plant organs.

6. Chemicals: Chemicals like carbon, hydrogen, oxygen, nitrogen, phosphorus, sulphur, etc. are needed for normal plant growth.

7. Mechanical stimuli: Contact has an effect on growth. This retards the growth.

Internal factors affecting growth:

1. Heredity: Plants grow rapidly upto a certain stage. Eventually the speed decreases.

2. Stored food: Food is stored within the plant body. The rate of growth is proportional to the amount of stored food.

3. Carbohydrate and nitrogen ratio: There should be a proper balance maintained between carbohydrate and nitrogen. Only then both vegetative and reproductive phases are possible in a plant.

4. Hormones or growth promoting substances: Plant growth is regulated by certain chemical substances produced by plants.

Edaphic factors affecting growth: Edaphic factors are factors which are connected with the soil.

1. Water: Water is essential for all the metabolic activities in a plant. Deficiency of water affects cell division and cell enlargement.

2. Oxygen: If the roots cannot obtain oxygen, they cannot breathe. This affects the growth of plants.

3. Soil temperature: The intake of mineral salts and water by roots depends on appropriate soil temperature.

4. Mineral salts: The quantity and nature of mineral salts absorbed by the plant influence its growth.

5. The pH or hydrogen ion concentration: Very high or very low pH are harmful to plant growth, as they affect the beneficial microorganisms that provide mineral salts by decomposing dead plants and animals as well as by fixing atmospheric nitrogen for the plants.

Biotic factors that affect growth: Any living organism that affects the growth of plants are called biotic factors.

1. Competition among plants: If the area in which plants are growing is overcrowded, none of the plants there will enjoy normal growth. The presence of weeds among cultivated plants decreases the rate of growth drastically.

2. Grazing animals: Grazing animals cause heavy destruction and even the death of plants. Certain plants are provided with spikes, prickles, stinging hairs and poison which help the plant to overcome this problem.

3. Pollinating agents: In the absence of pollinating agents like animals and insects, fruits may fail to develop.

4. Parasites: Many parasites like bacteria, fungi, worms and insects affect the growth of plants.

5. Soil organisms: Saprophytic bacteria and fungi decompose organic matter into its chemical constituents and make them available to the plants for their healthy growth. Nitrogen fixing bacteria converts nitrogen to nitrates which are helpful for plant growth. Earthworms improve the air content of the soil.

Some basic concepts

1. Growth involves progressive changes in the form of an organism.
2. The stages of growth are formative phase, enlargement phase and maturation phase.
3. Growth is more in the meristematic region.
4. There are external, internal, biotic and edaphic factors which affect growth.
5. Growth regulators also affect the growth of plants.
6. Some of the important growth regulators are auxin, gibberlin, etc.
7. There are some synthetic growth regulators.
8. Growth can be measured by an auxonometer.

REVISION TIME

I. Questions

1. Explain clearly what you understand by the term 'growth'.
2. Name the region of growth in the apex of
a. stem b. root.
3. Distinguish between primary growth and secondary growth.
4. What are growth regulators?
5. Describe an experiment to demonstrate the effect of auxins on the growth of an oat coleoptile.
6. List the factors necessary for the healthy growth of a seedling and indicate the importance of each factor.
7. An orange tree loses a large number of fruits prematurely. What can be done to prevent this?

II. Fill in the blanks:

1. The thickness of a stem is increased by the _____ meristem.
2. Gibberellic acid is obtained from _____.
3. Secondary tissues formed in the spring are called _____.
4. Vitamin A helps in _____.
5. Spring wood and summer wood together are called _____.

III. Put an X next to the correct answer in the following questions:

1. The instrument used to measure the rate of growth is:

- a. potometer. ☐
- b. auxonometer. ☐
- c. galvanometer. ☐
- d. klinostat. ☐

2. The entire period of growth is called the

- a. grand period of growth. ☐
- b. photoperiod. ☐
- c. thermoperiod. ☐
- d. chemotropism. ☐

IV. Say whether the following are true or false:

- 1. Growth is at its maximum during spring.
- 2. Meristem is a group of cells undergoing division.
- 3. Hormones are produced in large quantities and have little physiological effects.
- 4. Gibberellic acid helps the plant to grow more.
- 5. Growth in a plant takes place at the node.

4 Reproduction

reproduction - vegetative and sexual reproduction in plants - natural and artificial methods of vegetative propagation in plants - life cycle in lower and higher plants - sexual reproduction in unisexual and bisexual plants - germination.

You learnt in class 6 about the vegetative and reproductive stages in plant life, and that the production of a flower is the beginning of the reproductive stage. Now we shall learn more about the different kinds of reproduction.

4.1 Vegetative and sexual reproduction

Certain plants do not possess specific reproductive parts. The vegetative parts of these plants can bring about reproduction. This is called vegetative reproduction.

Normally, plants produce flowers which in turn produce the reproductive cells called gametes. These gametes fuse and bring about reproduction. This is called sexual reproduction.

VEGETATIVE REPRODUCTION

When a new plant is produced from any of the vegetative parts, such as the root, stem or leaf, it is called vegetative reproduction. Vegetative reproduction can be by natural or artificial methods.

Natural vegetative reproduction: This is made possible because of the following structures:

1. Sub-aerial stems: The sub-aerial stems such as the runner, the stolon, the sucker and the offset develop into new plants in the course of their

growth. These may be detached from the mother plant and grown independently.

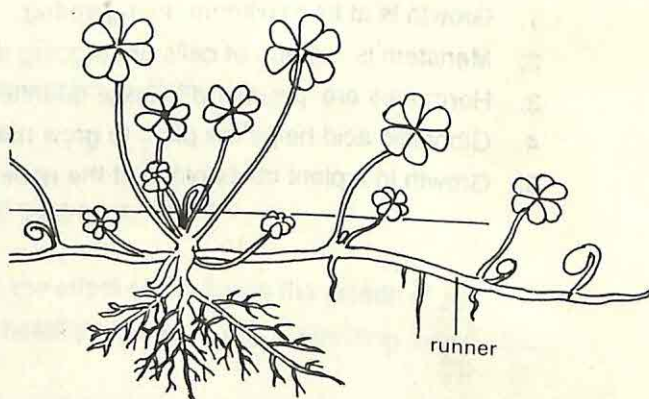


Fig. 4.1 Runner of wood sorrel

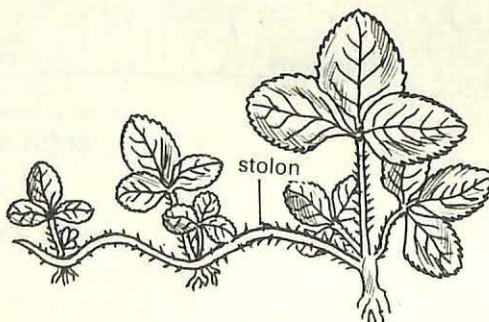


Fig. 4.2 Stolon of wild strawberry

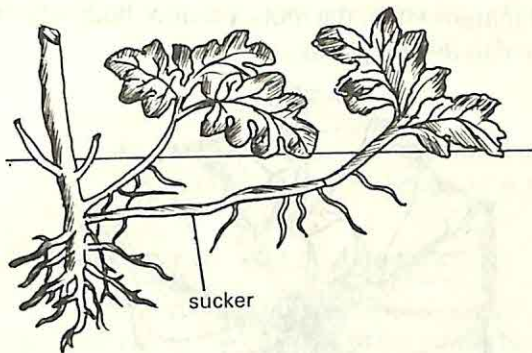


Fig. 4.3 Suckers of chrysanthemum

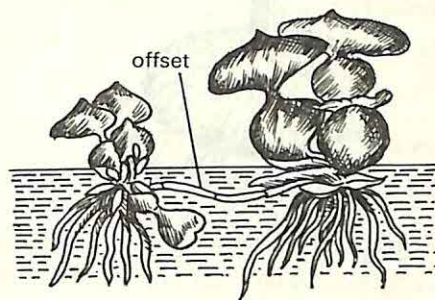


Fig. 4.4 Offset of water hyacinth

2. Underground stems: Underground stems like rhizome, corm, tuber and bulb store food. In addition to this, they are helpful in vegetative propagation. The underground parts of the stems remain dormant during unfavourable conditions. When the conditions are favourable the terminal and the axillary buds give rise to new aerial parts.

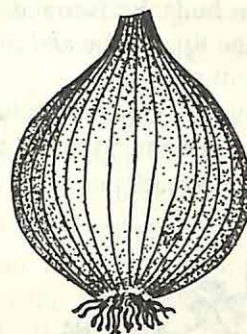


Fig. 4.6 Bulb of onion

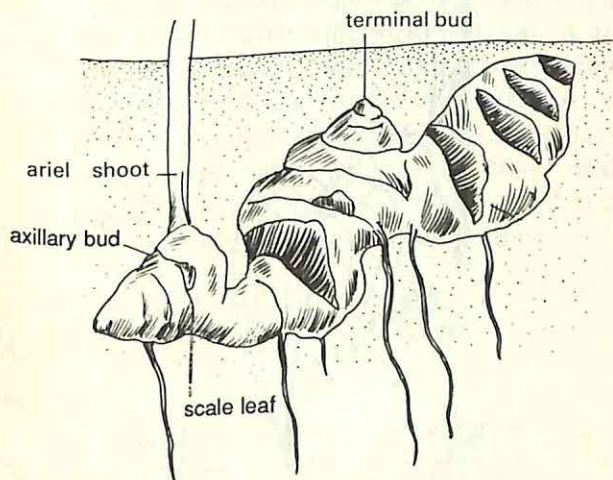


Fig. 4.5 Rhizome of ginger

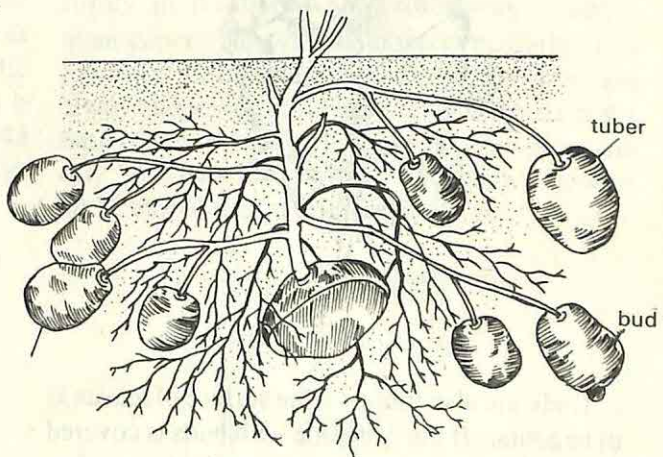


Fig. 4.7 Tuber of potato

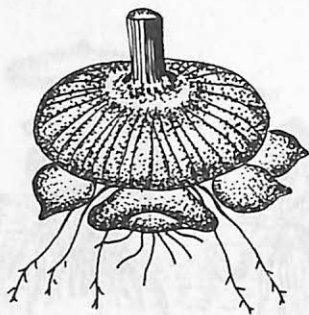


Fig. 4.8 Corm of gladiolus

3. Adventitious buds: Buds found in any other part apart from the tip and the axil of a plant are known as adventitious buds.

a. Buds on leaves: The leaves of bryophyllum produce a number of buds on their edges. When they fall to the ground each one of them develops into a new plant.

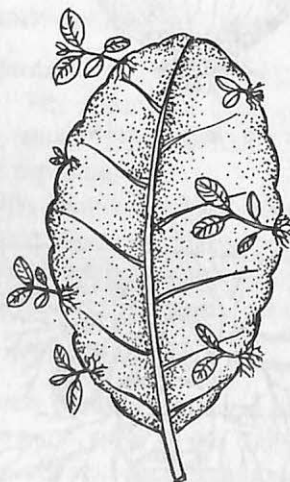


Fig. 4.9 Bryophyllum

Buds are also found on the surface of leaves as in begonia. If the leaf area with buds is covered with soil, it will give rise to new plants.

b. Buds on roots: In plants like millingtonia and margosa tree, the roots produce buds which give rise to new plants.

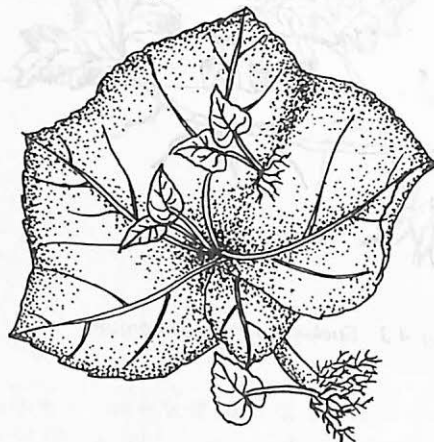


Fig. 4.10 Begonia

c. Bulbils: Sometimes the buds are modified into peculiar structures called bulbils. Bulbils are mostly found in the axils, e.g., wild yam and tiger lily. Sometimes bulbils are formed from flower buds, e.g., garlic. These buds are formed due to the accumulation of food. When these are dropped, they develop into new plants. They are also found on leaf tips.

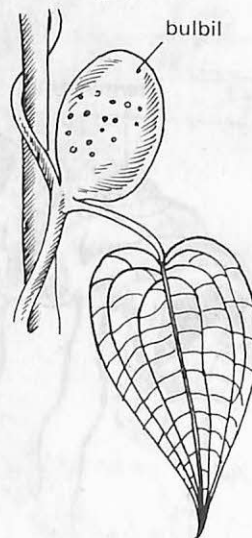


Fig. 4.11 Bulbil of wild yam

Activity 1: Pluck a mature leaf of *bryophyllum*. Tie it to the crossbar of a window and observe it after a few days. Adventitious buds will be formed on the margins of the leaf.

Activity 2: Plant a part of any underground stem with the terminal or axillary bud in the soil and observe how a new plant is produced.

Artificial vegetative reproduction:

1. Cutting: A mature branch with nodes and internodes is cut and planted in the soil. The top portion of the cutting can be covered with cowdung or moist clay to prevent drying up of the cutting. The cutting should be watered regularly. The separated branch is called a cutting. After a few days, the branch will develop buds and roots and become a new plant, e.g., rose, sugarcane, hibiscus.



Fig. 4.12 Vegetative propagation by cutting.

2. Layering: The mature branches are bent into the soil with their tips above the ground. A stone is kept above the portion of the branch which is buried underground to prevent uprooting. The plant is watered regularly. After some days it strikes roots below and leaves above. If this portion is cut off from the mother plant, it can exist independently, e.g., rose, jasmine.

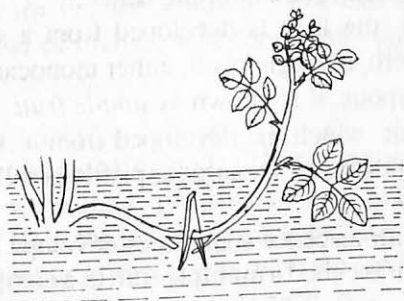


Fig. 4.13 Layering (rose)

3. Grafting: This method is useful for getting good varieties of plants. The advantages of grafting are high yield, and new and better quality of fruits and flowers.

Here the stems of two closely related plants are united together under suitable conditions. The existing variety is known as the *stock* and the variety to be grafted is known as the *scion*. There are various types of grafting like approach grafting, crown grafting and bud grafting, e.g., mango, grapes, guava.

a. Approach grafting: This is practised for grafting guava, mango and sapota. The stock is grown in a pot and the scion is grown in the soil. When both stock and scion have reached a thickness of about 1.5 cm, they are brought together. A branch of the scion is bent towards the stock and a small slice is cut off from the stem of the stock. The two cut portions are carefully brought into contact with each other and are held firmly in position with grafting wax or parchment paper. The plant is watered regularly. In a few days, the two parts fuse. the graft portions are always kept wet or moist. After some days the base of the scion and the top of the stock are cut off. This new plant will now produce flowers and fruits of the quality of the scion.

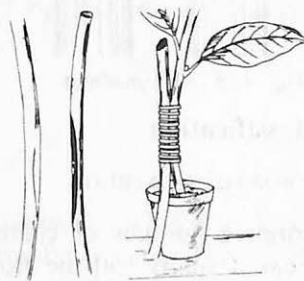


Fig. 4.14 Approach grafting

b. Crown grafting: This can be called stem grafting. The scion and stock of the same thickness are selected. The stems are cut obliquely and the cut surfaces are brought together and tied firmly with the help of grafting wax.



Fig. 4.15 Crown grafting

c. Bud grafting: Bud grafting is done to bring together the bud of a scion and a portion of the stock plant. A 'T' shaped incision is made on the bark of the stock. A portion of the stem of the scion with a bud is selected. This is placed in the incision on the stock, and bandaged firmly with grafting wax, e.g., apple, orange and rose.

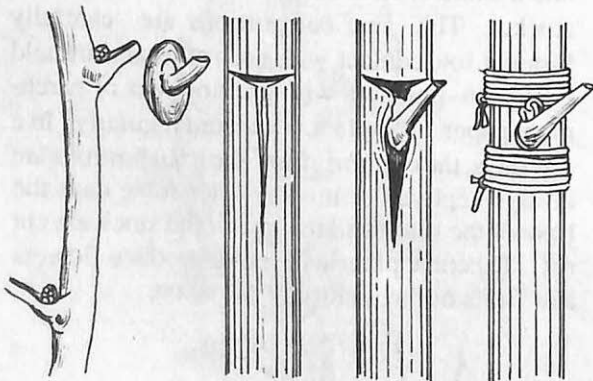


Fig. 4.16 Bud grafting

4.2 Fruits - classification

DEVELOPMENT OF SEEDS AND FRUITS

After fertilization, a number of changes take place in a flower. Usually all the floral parts wither away, except the gynoecium. The ovary

enlarges and forms the fruit. The ovules are changed into seeds. Sometimes the fruit is formed without fertilization. This is termed *parthenocarpy*. The fruit wall is known as the pericarp and consists of three layers. They are the outer *epicarp*, the middle *mesocarp* and the inner *endocarp*.

A *true fruit* is the transformed and mature ovary. A fruit is said to be a *false fruit* if any part of the flower other than the ovary becomes the fruit, e.g., apple in which the thalamus becomes fleshy and forms the fruit. In the cashew fruit the pedicel forms the fruit.

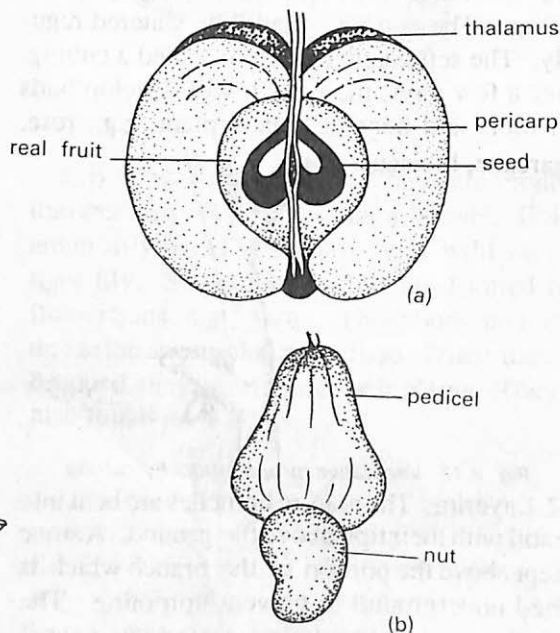


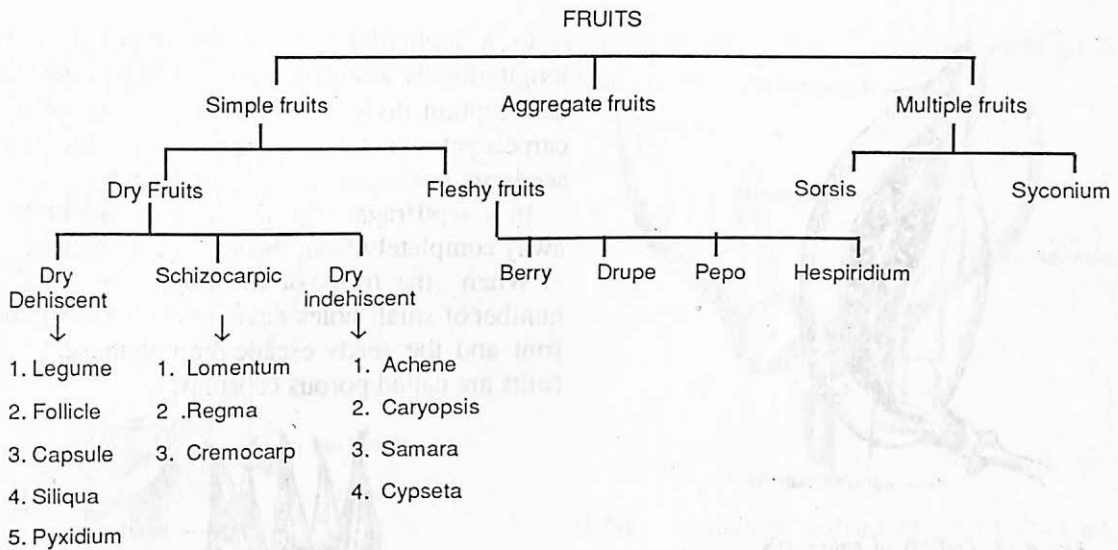
Fig. 4.17 (a) L.S. of Apple fruit
(b) Cashewnut

Fruits may be classified into simple fruits, aggregate fruits and multiple fruits.

When the fruit is developed from a single flower with a single pistil, either monocarpous or syncarpous, it is known as *simple fruit*.

A fruit which is developed from a single flower with many apocarpous pistils is called an aggregate fruit.

The inflorescence sometimes develops into a fruit and it is called a multiple fruit or a composite fruit.



SIMPLE FRUITS

Simple fruits may be classified into simple dry fruits and simple fleshy fruits. If the pericarp is dry the fruit is called simple dry fruit, and if it is fleshy it is called simple fleshy fruit. Simple dry fruits are further divided into dry dehiscent fruits, dry indehiscent fruits and schizocarpic fruits.

Dry Fruits

1. When the dry pericarp splits open to expose the seeds, the fruit is described as dry dehiscent fruit.

2. When the pericarp does not split open to liberate the seeds it is called dry indehiscent fruit.

3. In schizocarpic fruits, there is splitting of the pericarp but the seeds are not exposed. They consist of many one-seeded parts called mericarps or cocci.

1. Dry dehiscent fruits

a. Legume or pod: This develops from a monocarpellary pistil with marginal placentation. Here the pericarp is dry and thick. It splits open along both margins, with the seeds attached to the ventral suture, e.g., bean, pea.

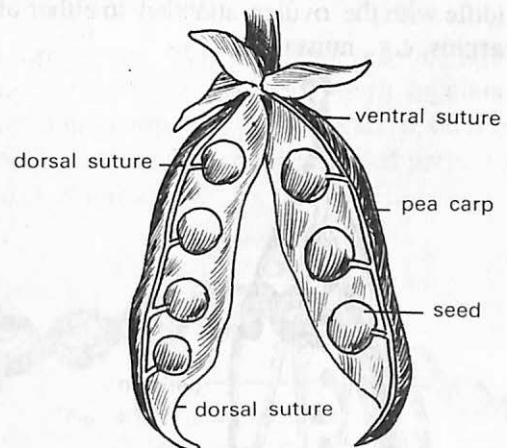


Fig. 4.18 Pea fruit (legume)

b. Follicle: This also develops from the monocarpellary pistil. The pericarp breaks only along the ventral suture, e.g., calotropis, michelia

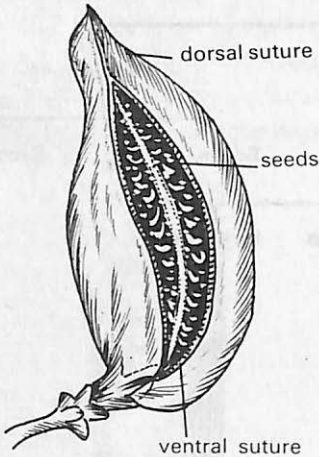


Fig. 4.19 Follicle of *calotropis*

c. Siliqua: This fruit develops from a bi-carpellary superior ovary. The pericarp splits into two halves from below, leaving the septum in the middle with the ovules attached to either of the margins, e.g., mustard.

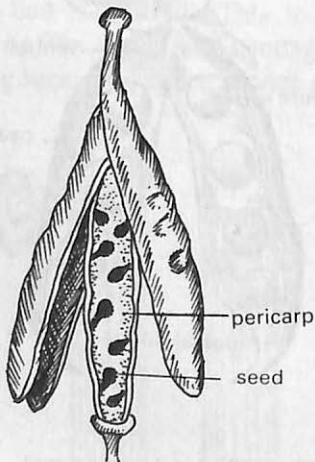


Fig. 4.20 Siliqua of mustard

d. Capsule: Dry dehiscent fruits derived from syncarpous pistils are commonly known as capsules.

In a loculicidal capsule, the pericarp splits longitudinally along the middle of each locule into as many valves as there are carpels, e.g., lady's finger, cotton.

In a septicidal capsule the pericarp splits longitudinally along the partition or septa so that each septum divides into two halves and all the carpels get separated from one another. Here the seeds are not exposed, e.g., *aristolochia*.

In a septifragal capsule the pericarp breaks away completely from the septa, e.g., *datura*.

When the fruits of the poppy are ripe, a number of small holes develop on the top of the fruit and the seeds escape through these. Such fruits are called porous capsules.

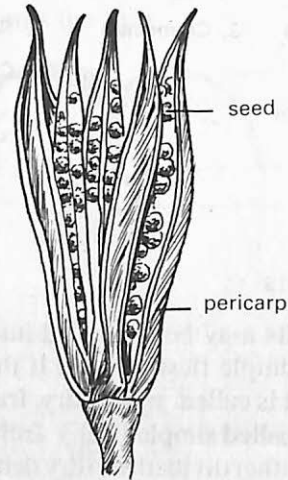


Fig. 4.21 Lady's finger

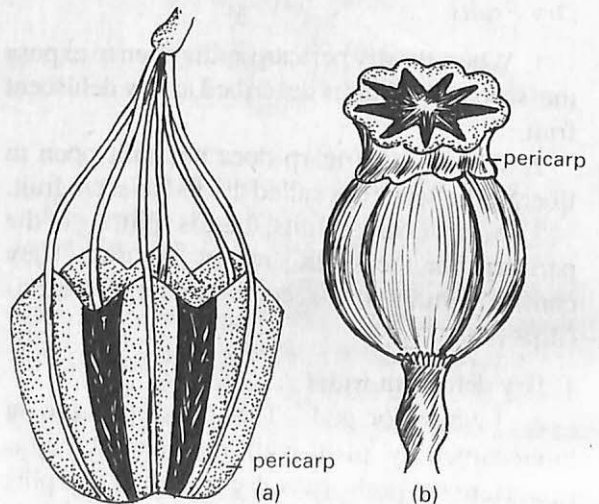


Fig. 4.22 (a) *Aristolochia*
(b) Poppy fruit

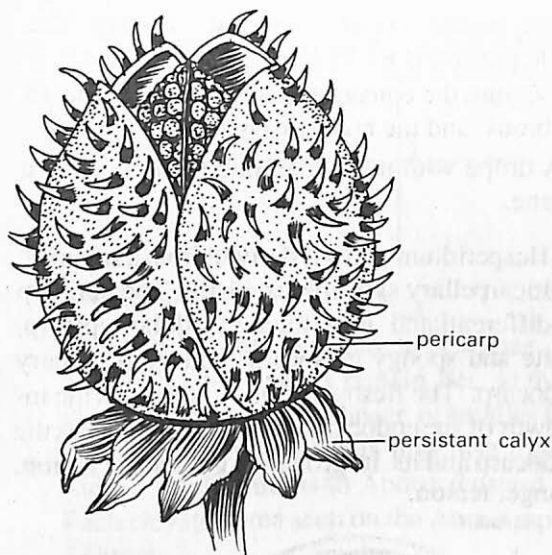


Fig. 4.23 *Datura*

e. Pyxidium: This develops from a simple one-celled ovary. When the fruit ripens the upper portion separates as a lid, e.g., portulaca.

2. Dry indehiscent fruit

a. Achene: This is a one-celled, one-seeded fruit. It develops from a one-celled ovary. The pericarp is dry, membranous and free from the seed coat, e.g., fruit of climatis.

b. Caryopsis: This is also referred to as grain. It is formed from a simple ovary. The pericarp of the fruit is very thin and is fused with the seed coat, e.g., paddy, maize.

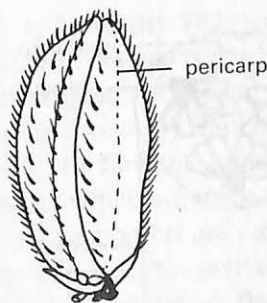


Fig. 4.24 *Caryopsis of paddy*

c. Samara: A winged achene is a samara. It develops from a syncarpous ovary. The pericarp

is modified into wings, e.g., gyrocarpus, pterocarpus, acer.

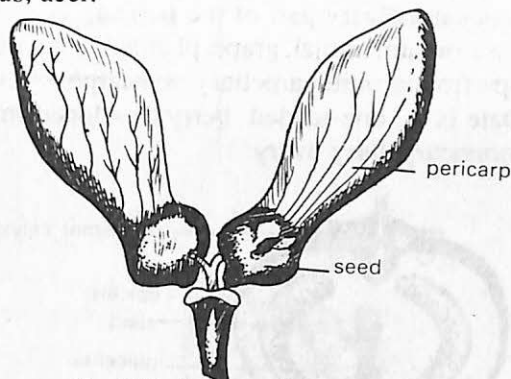


Fig. 4.25 *Samara of Acer*

d. Nut: An achene with a large, hard, thick and woody pericarp is called a nut, e.g., cashewnut.

e. Cypsela: This is one-seeded and is developed from an inferior ovary, e.g., tridax, helianthus.

3. Schizocarpic fruits

a. Lomentum: When the fruit is formed fully, many segments can be seen. Each segment is called a mericarp. The fruit breaks open transversely into a number of one-seeded parts, e.g., *Acacia arabica*.

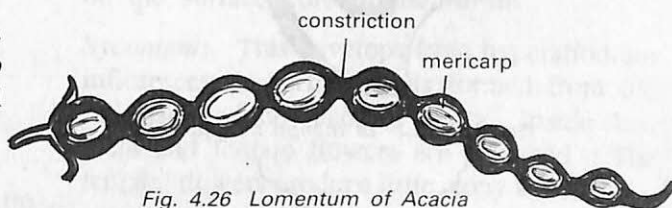


Fig. 4.26 *Lomentum of Acacia*

b. Regma: When the fruit ripens, the pericarp breaks open longitudinally into a number of one-seeded mericarp, e.g., castor, abutilon.

c. Cremocarp: An inferior, bicarpellary, syncarpous ovary gives rise to a cremocarp. When the fruit ripens, it breaks into two mericarps, e.g., coriandrum.

Fleshy fruits :

1. Berry: The pericarp is differentiated into a

membranous outer covering called epicarp and a fleshy endocarp. Seeds are embedded in the endocarp. Every part of the pericarp is edible, e.g., tomato, brinjal, grape, plantain. This develops from a multicarpellary syncarpous ovary. Date is a one-seeded berry developed from a monocarpellary ovary.

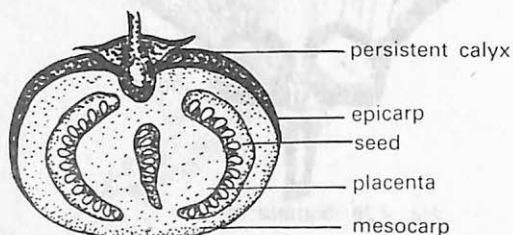


Fig. 4.27 L.S. of tomato fruit (berry)

2. **Drupe:** It develops from a monocarpellary or multicarpellary, syncarpous pistil. The pericarp is differentiated into an outer thick epicarp,

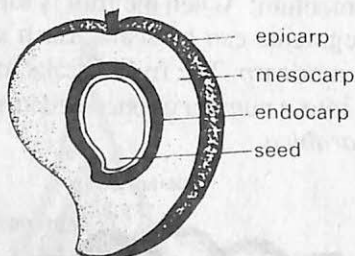


Fig. 4.28 L.S. of mango fruit (drupe)

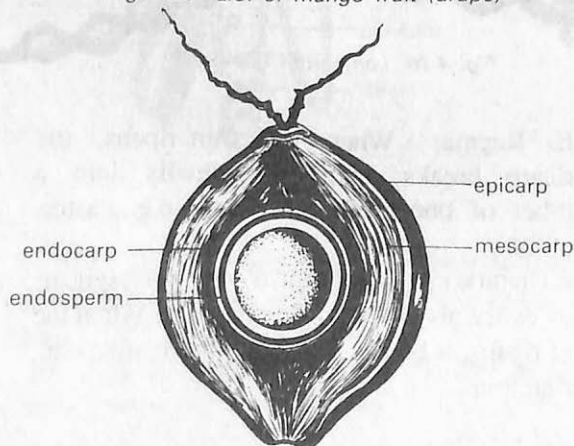


Fig. 4.29 L.S. of coconut fruit (drupe)

a fleshy mesocarp and a very hard endocarp. The edible portion is the mesocarp, e.g., mango. In coconut, the epicarp is leathery, the mesocarp is fibrous and the endocarp is stony.

A drupe with more than one seed is called a pyrene.

3. **Hesperidium:** This is derived from a superior, multicarpellary syncarpous pistil. The pericarp is differentiated into thick glandular epicarp, white and spongy mesocarp and thin papery endocarp. The fleshy and juicy portion is the in-growth of the endocarp. The edible portion is the endocarp and its in-growth, e.g., orange, lemon.

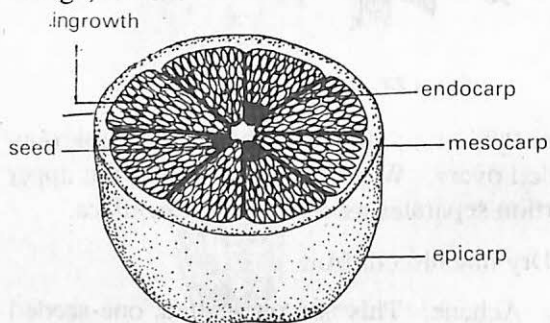


Fig. 4.30 C.S. of orange fruit (hesperidium)

4. **Pepo:** This is derived from an inferior, tricarpeal syncarpous pistil. It has a thick and leathery epicarp and a fleshy mesocarp. The mesocarp along with the fleshy placenta are the edible portions of the fruit, e.g., cucumber.

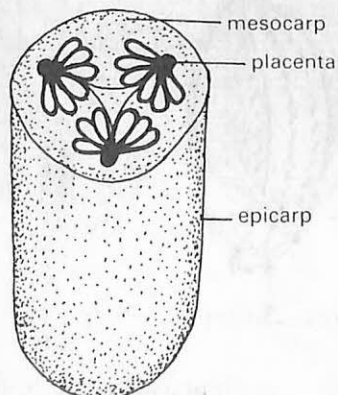


Fig. 4.31 C.S. of cucumber fruit (pepo)

Activity 3: List in a tabular form, as given below, all types of fleshy fruits.

NAME OF THE TYPE OF FRUIT	DEVELOPMENT	DESCRIPTION	EDIBLE PORTION

AGGREGATE FRUITS

These fruits develop from apocarpous pistils. The individual carpels remain free so that each flower gives rise to a cluster of smaller fruits as in polyalthia or the carpels may fuse together to form a single fruit as in Annona (custard apple). Each elevated area seen on the Annona represents a carpel.

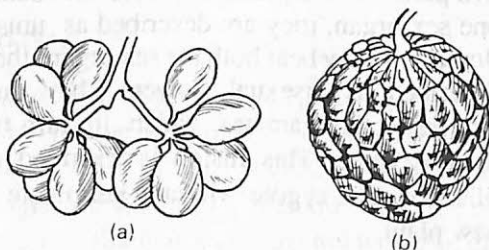


Fig. 4.32 Aggregate fruit

(a) polyalthia

(b) annona

MULTIPLE FRUITS

Sorosis: 1. Jackfruit: This has unisexual inflorescence. The female spike develops into the fruit. The longitudinal section shows two halves with a central axis which is the peduncle. The perianth of the flowers are modified into sweet edible flakes which are thick and succulent. Inside the edible portion are embedded bag-like structures which are the pericarp. In between the edible flakes are numerous flat, elongated whitish structures which are not edible. These represent the sterile or unfertilized flowers. The hard portion outside the fruit are the external sheaths. The styles pass through these.

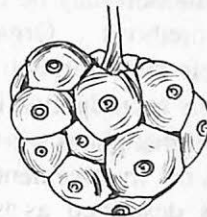


Fig. 4.33 Multiple fruit (morinda)

2. The pineapple: The fruit develops from a spike. The axis of the inflorescence is fleshy. This continues to grow beyond the fruit and form a few leaf-like tracts which are found on the upper side of the fruit. The polygonal areas on the surface represent the flower.

Syconium: This develops from hypenthodium inflorescence. The fruit is formed from the receptacle which becomes fleshy. Inside this, male and female flowers are arranged. The female flowers produce little stony achenes.

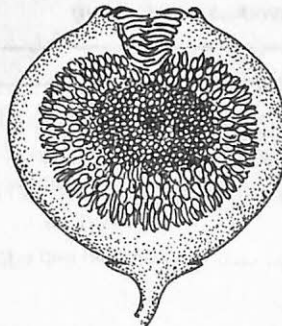


Fig. 4.34 Syconus of fig (ficus)

Activity 4: Investigate some fruits and seeds and find out the botanical nature of the edible parts, if any.

4.3 Life cycles of plants

Mango trees produce seeds from which other mango trees grow. The resemblance of the offspring to the adult is the characteristic feature of life. Reproduction may be brought about by one or more methods. Organisms tend to perpetuate their kind through reproduction. In the lower plants reproduction is done through spores. In the higher plants it is through gametes. When there is no involvement of organs in the life cycle, it is described as asexual reproduction. Asexual reproduction can be achieved by spores, budding, fragmentation, fission and by vegetative reproduction.

In unicellular plants reproduction is through spores, budding or fission. In multicellular plants it is by fragmentation, vegetative reproduction and sexual reproduction.

In Bryophytes and Pteridophytes the sporophytic generation is alternated by the gametophytic generation. This method of reproduction is described as *alternation of generation*. A

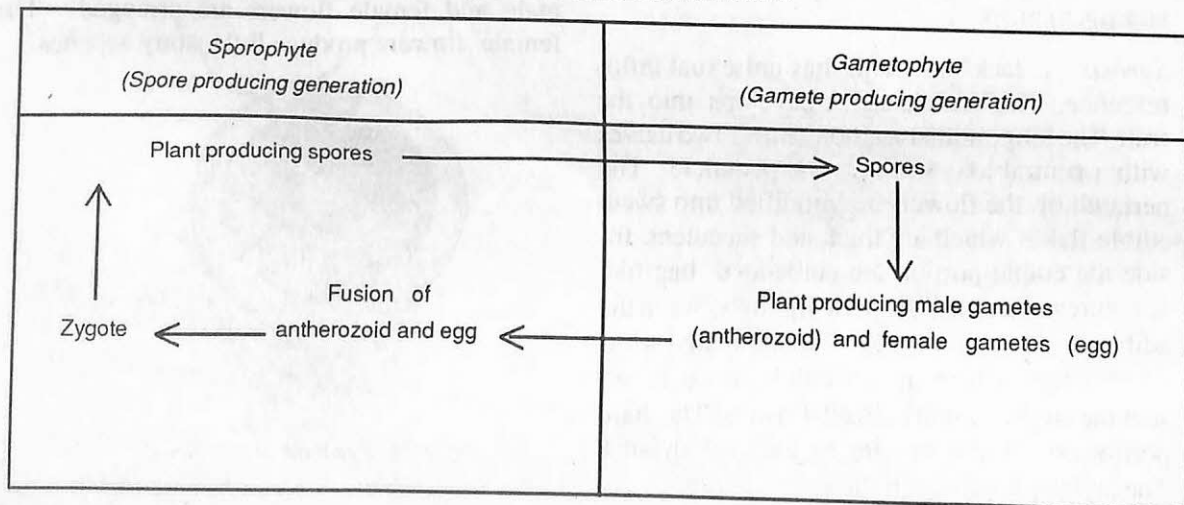
sporophyte is a plant which produces spores.

These, on germination, produce gametophytes. the gametophyte is a plant which bears sex organs. These sex organs produce gametes. The male sex organs can be called the *antheridia* which produce The male gametes known as *antherozoids*. The female sex organs are called *archegonia* which produce the female gametes or eggs. The fusion of these results in the formation of a *zygote* which will in turn produce a new plant.

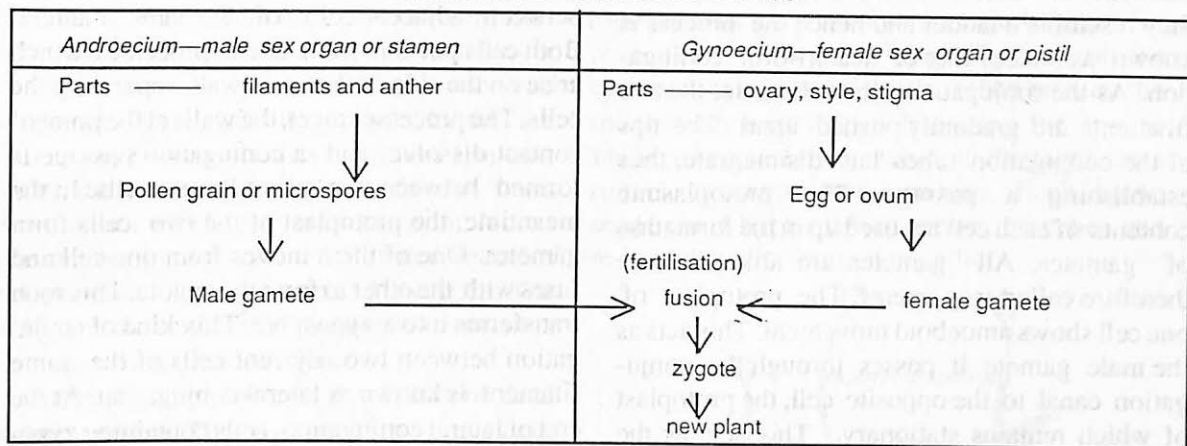
In angiosperms, the flowers are the reproductive parts of the plant. If the flowers bear only one sex organ, they are described as unisexual flowers. If they bear both the sex organs they are described as bisexual flowers. They produce the respective gametes which in turn fuse to form a zygote. This fusion is described as fertilisation. The zygote will later germinate into a new plant.

By these methods the reproduction and life cycles in the lower and higher plants are continued.

LIFE CYCLE IN THE LOWER PLANTS



LIFE CYCLE IN THE HIGHER PLANTS



4.4 Life cycles of lower plants

SPIROGYRA

Structure: Spirogyra is a green alga which occurs in the filamentous form. It is mostly found in fresh water ponds. The filaments entangle together and float on the surface of ponds. The filaments are covered with mucilage which explains the slimy texture. Spirogyra is commonly known as ‘mermaid tresses’ or ‘water silk’.

Each filament of spirogyra has a number of long cylindrical cells placed end to end. In a

filament, the base and apex are not distinguishable. Each cell has a thin layer of cytoplasm close to the wall. There is a large central vacuole. The cell wall is thick, and made up of cellulose. The nucleus is suspended in the vacuole by means of thin cytoplasmic strands. There are one or more chloroplasts. The chloroplasts are flat, ribbon shaped structures with a wavy margin. These are arranged in the form of spiral bands and so they are called *spiral chloroplasts*. In each chloroplast there are a number of conspicuous rounded bodies known as *pyrenoids* which store reserve food material. As the plant has chloroplast, it is autotrophic (can prepare its own food).

Activity 5: Go to a ditch, pond or lake and collect some green algae. Spread the filaments on a glass slide. Stain with iodine and observe the slide under a microscope.

Reproduction: In spirogyra, both vegetative reproduction and sexual reproduction take place.

1. Vegetative reproduction: The filaments break into short bits, each bit growing out into a new filament. This is known as *fragmentation*.

2. Sexual reproduction: Spirogyra reproduces sexually by a process called conjugation in

which two reproductive cells called isogametes fuse. There are two methods of conjugation in spirogyra. They are scalariform conjugation and lateral conjugation.

In scalariform conjugation two filaments are involved. The participating filaments are parallel to one another. At the points of contact, tubular outgrowths called *conjugation tubes* develop. When the cells of the participating

filaments are connected by conjugation tubes, they resemble a ladder and hence the process is known as ladder-like or scalariform conjugation. As the conjugation tubes elongate, the two filaments are gradually pushed apart. The tips of the conjugation tubes later disintegrate, thus establishing a passage. The protoplasmic contents of each cell are used up in the formation of gametes. All gametes are alike and are therefore called *isogametes*. The protoplast of one cell shows amoeboid movement. This acts as the male gamete. It passes through the conjugation canal to the opposite cell, the protoplast of which remains stationary. This acts as the female gamete. The contents of the two opposite cells fuse resulting in the *zygote*. Each zygote soon covers itself with a thick black resistant wall and becomes the *zygospore*. In scalariform conjugation, the cells of the filament producing the amoeboid gametes will be empty while those of the others producing non-motive gametes will contain zygospore.

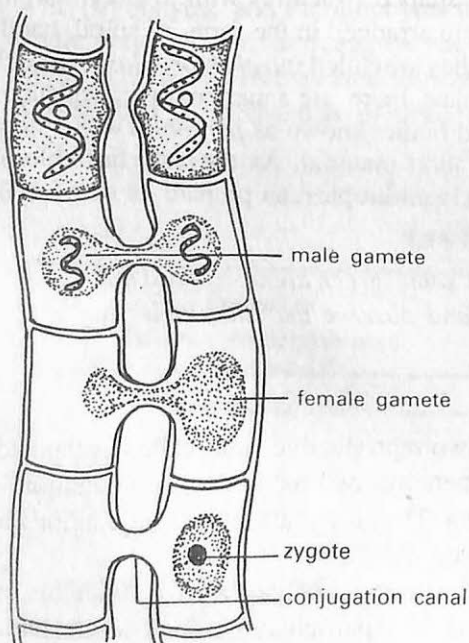


Fig. 4.35 *Spirogyra*

In lateral conjugation, conjugation takes place between adjacent cells of the same filament. Both cells put out short lateral processes which arise on the side of the cross wall separating the cells. The processes meet, the walls at the point of contact dissolve and a conjugation passage is formed between the two adjacent cells. In the meantime, the protoplast of the two cells form gametes. One of them moves from one cell and fuses with the other to form the zygote. This soon transforms into a zygospore. This kind of conjugation between two adjacent cells of the same filament is known as lateral conjugation. At the end of lateral conjugation, cells containing zygospores always alternate with empty cells.

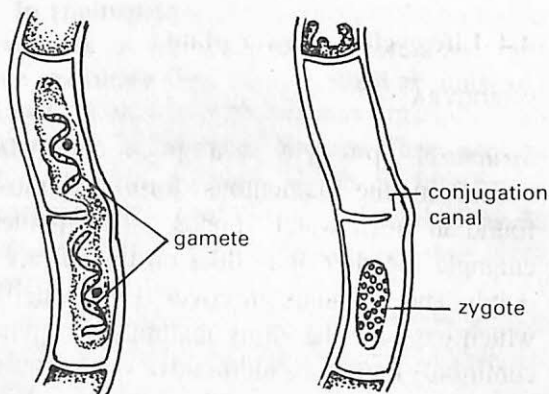


Fig. 4.36 *Spirogyra*-Scalariform conjugation

Germination of zygospore: The zygospores remain protected within their thick walls. After a period of rest and when conditions become favourable, the outer wall bursts and a small filament grows out of it. The cells of this small filament later divide to form an adult filament.

MUCOR

Mucor is a very common fungus, often found on dead organic matter, e.g., moist bread, rotten fruits or any other decaying food substance. It appears as a closely woven mass of silken thread on the decaying food substance. It is commonly known as mould.

Structure: The whole plant body is termed mycelium. It comprises a number of branching filaments known as hyphae. Each hypha is a slender branching filament surrounded by a cell wall composed of fungal cellulose. As the hyphae are without any cross walls, they are called aseptate. Within the hyphae, there is a continuous mass of cytoplasm which is granular in nature. It contains many minute nuclei, oil globules, vacuoles and granules of fat, protein and glycogen. The multinucleate condition of the hypha of *Mucor* is termed as coenocytic nutrition.

Mucor is a saprophytic fungus. It lives on dead organic matter. The hyphae of the fungus not only spread on the surface of the substrate but they also penetrate into the medium. The cytoplasm of the hyphae secrete enzymes. These enzymes digest the complex insoluble compounds and convert these into simple and soluble forms resulting in the decay of the organic matter. A watery solution of these products is absorbed by the hyphae.

For respiration, *Mucor* absorbs oxygen from the air. The carbon dioxide produced during respiration diffuses out of the hyphae.

Reproduction: Reproduction in *Mucor* takes place in two ways — *asexual reproduction* and *sexual reproduction*.

1. **Asexual reproduction:** When food is abundant and conditions are favourable, *Mucor* reproduces asexually by means of spores. At the time of asexual reproduction, certain vertical hyphae develop from the mycelium that spreads on the organic matter. These are called *sporangiophores*. After the elongation of the sporangiophore to a certain height, its tip becomes spherical to form the *sporangium*. A large amount of cytoplasm, many nuclei and reserve food migrate to the periphery of the sporangium. The central portion of the sporangium becomes highly vacuolated. It becomes separated by a dome-shaped cross wall. The central portion is sterile and is called *columella*. The cytoplasm at the periphery becomes divided into a large

number of multinucleate portions. These become rounded off, get covered by a dark protective wall. These form the *spores*. The wall of the sporangium is thin and brittle. When mature, the sporangium bursts open liberating the spores. These are carried by the wind. If they settle on a suitable medium, they germinate. Each spore sends out a hypha which grows, branches and re-branches producing a mycelium.

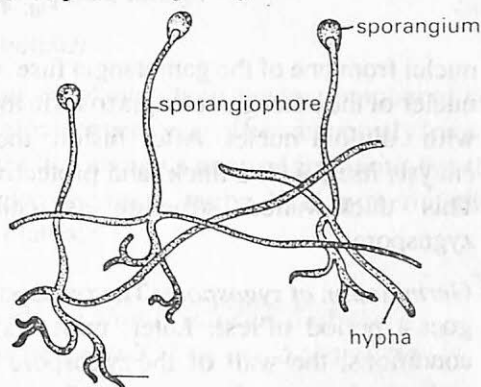


Fig. 4.37 *Mucor* mycelium with sporangia

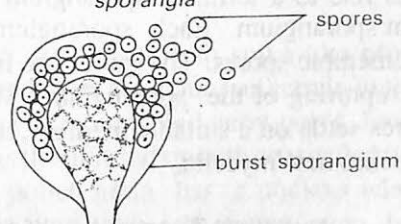


Fig. 4.38 Liberation of spores from sporangium

2. **Sexual reproduction:** Sexual reproduction is by means of conjugation. Hyphae, which are externally identical but physiologically different, are said to be of different strains. Two hyphae of two different strains called the *plus strain* and the *minus strain* touch each other. At the point of contact, they develop protuberances called conjugating tubes that gradually become club-shaped. Each conjugating tube divides to form a basal *suspensor* and a terminal *gametangium*. The gametangium has a dense mass of cytoplasm with more number of nuclei than in the suspensor. The walls of the two gametangia dissolve at the point of contact. The contents of the two gametangia mix with each other and the

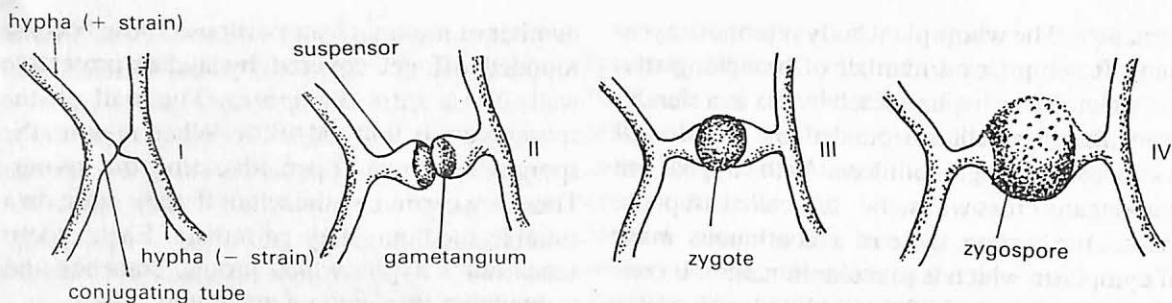


Fig. 4.39 Sexual reproduction

nuclei from one of the gametangia fuse with the nuclei of the other gametangia to form the zygote with diploid nuclei. After fusion, the zygote encysts itself with a thick and protective wall. This thick-walled structure is called the zygospore.

Germination of zygospore: The zygospore undergoes a period of rest. Later, under favourable conditions, the wall of the zygospore ruptures and a single germ tube grows out. This germ tube gives rise to a terminal sporangium called the germ sporangium. Each sporangium produces innumerable spores. The spores are liberated by the rupturing of the sporangium. When these spores settle on a suitable medium, they germinate into new mycelia.

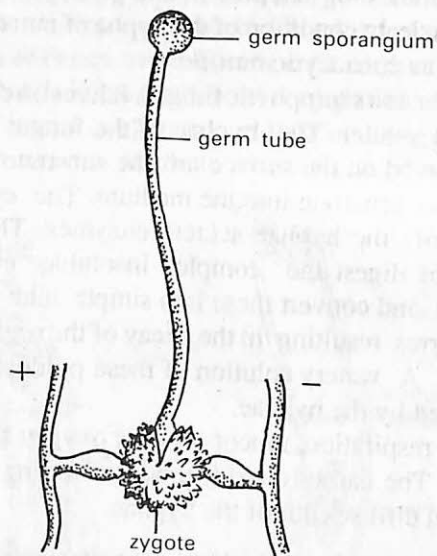


Fig. 4.40 *Mucor* - zygospore

Activity 6: Keep a slice of moist bread under a bell jar for 4–5 days. Tease a little bit of the mould in a drop of water on a glass slide. Observe the slide under a microscope.

Activity 7: Take three jars. Moisten a piece of bread and place some dust on top of it. Pour a little water into the bottom of one of the jars, swish it around and pour it out. Place the bread in the jar. Close the jar and keep it in a warm dark place.

Moisten a piece of bread and place some dust on top of it. Pour a little water into the bottom of the second jar, swish it around and pour it out. Place the bread in the jar. Close it and keep it in the refrigerator.

Place a dry piece of bread in the third jar. Add no water to the jar. Close it and set it in a warm dark place.

After three days examine the pieces of bread in the three jars. Compare the changes in them.

4.5 Life cycle in higher plants

Plants are classified into three groups according to their life span as *annuals*, *biennials* and *perennials*.

ANNUALS

These are plants which complete their life cycle within a year or a season. Within this period they grow from seed, put forth flowers and fruits and then die. The time taken to complete the life cycle may be a few months or a year, e.g., paddy, bean, mustard.

BIENNIALS

Biennials live for two seasons. During the first

season they grow from seeds and manufacture plenty of food. This food is stored up in some of their parts. During the second season, the stored food is used up in producing flowers and fruits. This exhausts the stored food completely and as a result the plant dies. In a biennial, the first season is utilised for vegetative activity and the second season for reproductive activity, e.g., carrot, radish, turnip.

PERENNIALS

These are plants which live for a number of years and flower every year. They are mostly trees and shrubs like mango, tamarind and ixora but there are also perennial herbs like turmeric, ginger and plantain.

Activity 8: Go to the school garden and list all the plants you can find there. Categorise them into annuals, biennials and perennials. Prepare a chart with drawings or pictures of all these plants.

FERTILIZATION

After pollination the next step in reproduction is fertilization. Fertilization means the fusion of the male and female gametes. Male gametes are produced by pollen grains in the anther and the female gametes are formed in the ovule.

Structure of a pollen grain: Each pollen grain has an outer coat called the exine which may be

smooth, warty or with spike-like projections. Here and there the exine has certain unthickened areas. These are called germ pores. Inner to the exine is the thin and smooth coat called the intine. Each pollen grain has a nucleus which soon divides into two, sometimes even before its transference from the anther to the stigma. One of them is called the *vegetative nucleus* or *tube nucleus* and the other, the *generative nucleus*.

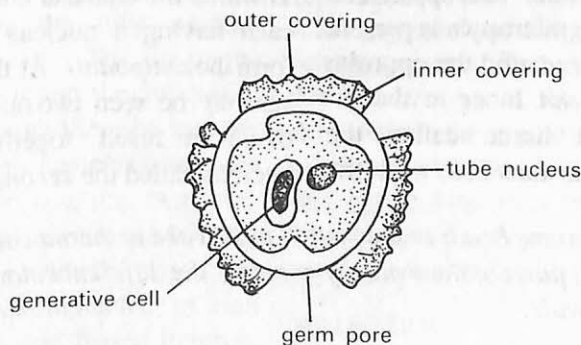


Fig. 4.41 Structure of a pollen grain

Activity 9 : Take the pollen grains from *hibiscus*, *datuna* and *helianthus* and observe their ornamentation under the microscope.

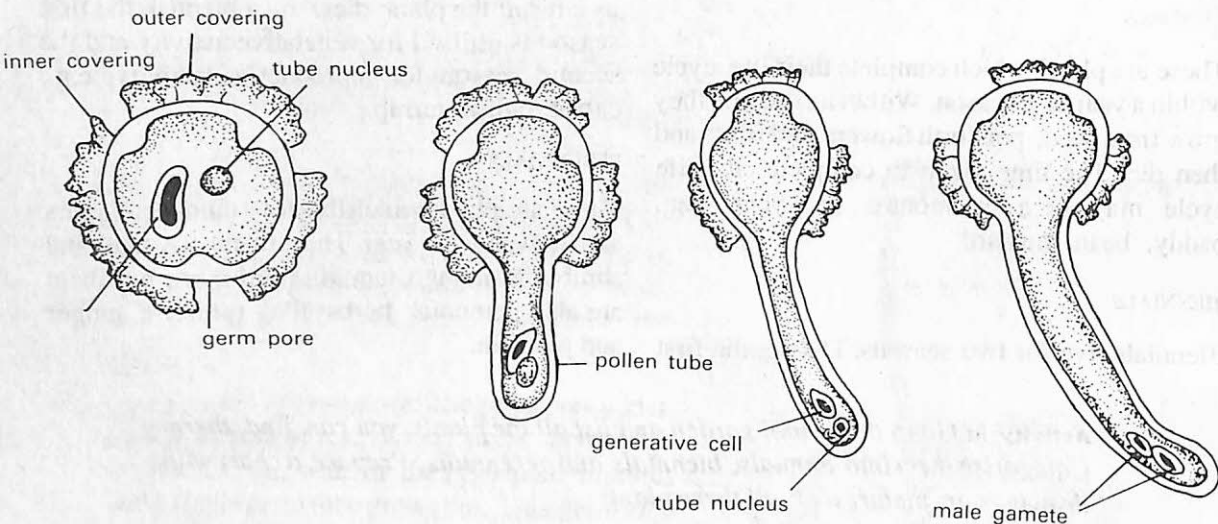


Fig. 4.42 Germination of a pollen tube

Structure of the ovule : Each ovule is slightly spherical or oval in shape. It is attached to the placenta by means of a stalk called the *funicle*. The place of the attachment of the funicle with the ovule is called the *hilum*. Each ovule has two coverings called *integuments*. The integuments do not cover the ovule completely but leave a very minute opening called the *micropyle*. The end of the ovule where the micropyle is present is called the *micropylar end*, and the opposite end is called the *chalazal end*. Inner to the integuments is a nutritive tissue called the *nucellus*. Embedded in the nucellus, near the

micropylar end is a large cell called the *embryo sac*.

In the embryo sac there are three cells each having a nucleus in it near the micropylar end. These cells together constitute the *egg apparatus* of the three cells, the middle one is called the *egg* and the other two are called the *synergids*. Towards the chalazal end there are three cells each having a nucleus in it. These together form the *antipodals*. At the centre of the embryo sac may be seen two nuclei which in a mature ovule are fused together forming a single nucleus called the *secondary nucleus*.

Activity 10: Take some beads and common pins. Take a thermocole board and show the different parts of the ovule by pinning the different coloured beads in the shape of an ovule.

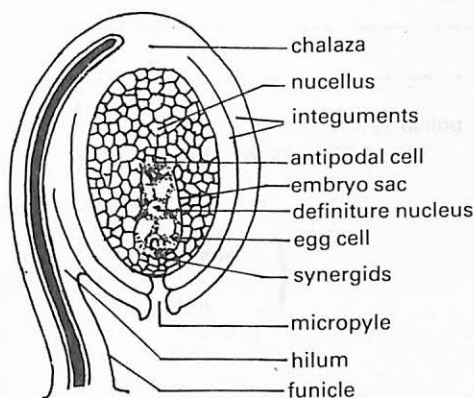


Fig. 4.43 Structure of a mature ovary

Fertilization: The pollen grains carried to the stigma by the different agents, get attached to the sticky stigma. Then a tube grows through one of the germ pores. This tube is called the *pollen tube*. At the time of pollen germination, its outer coat bursts open and the inner one grows out into the tube. The tip of the pollen tube secretes enzymes that dissolve the tissues of the stigma and the style through which it grows towards the *micropyle* of the ovule. The tube nucleus of the pollen grain controls the formation of the pollen tube.

As this pollen tube grows towards the micropyle, the generative cell divides to form two male gametes with a small amount of cytoplasm. By the time the tip of the pollen tube reaches the *embryo sac*, the tube nucleus disintegrates and disappears. The tip of the pollen tube now breaks open and the contents of the pollen grain flow through the tube into the embryo sac. One of the male gametes fuses with the egg cell and forms the *oospore* or *zygote*. This is called *true fertilization* or *syngamy*. The second male gamete fuses with the secondary nucleus to form the endosperm nucleus to form the *endosperm*. As this second fusion involves a male gamete it is also considered as fertiliza-

tion. These two fertilizations constitute double fertilization.

Soon after these two fusions, several changes take place in the ovule. The synergids and the antipodals disintegrate and disappear. The zygote develops into the embryo. The embryo consists of the primary axis and one or two thick leaves called *cotyledons*. The primary axis has two portions, *radicle* which develops into the root system and the *plumule* which develops into the shoot system of the plant.

If the seed has a single cotyledon, it is called a *monocotyledonous seed*. If it has two, it is called a *dicotyledonous seed*. The two integuments undergo certain changes and become the seed coats. The outer integument forms the outer seed coat called the *testa* and the inner integument becomes the inner seed coat called the *tegmen*. The ovule becomes the seed. The ovary grows bigger, slowly changes its colour and finally becomes the fruit. The other parts of the flower, namely, the sepals, petals, stamens and the style now wither and fall off.

4.6 Sexual reproduction in unisexual and bisexual plants

In class 6, we learnt that a flowering plant, after establishing its vegetative parts, produces reproductive parts which aid in raising a new generation of its species. We also learnt about the parts of a flower. Flower is the reproductive part of a plant. The androecium is the male reproductive organ and the gynoecium is the female reproductive part. The androecium produces male gametes and the gynoecium produces the female gametes. The male and female gametes produce the zygote. As we have seen earlier in this chapter the zygote gives rise to a new plant. Since the gametes develop in the androecium and gynoecium, they are collectively known as *essential whorls*. Now we will learn about sexual reproduction in detail.

POLLINATION

Male and female gametes are produced in differ-

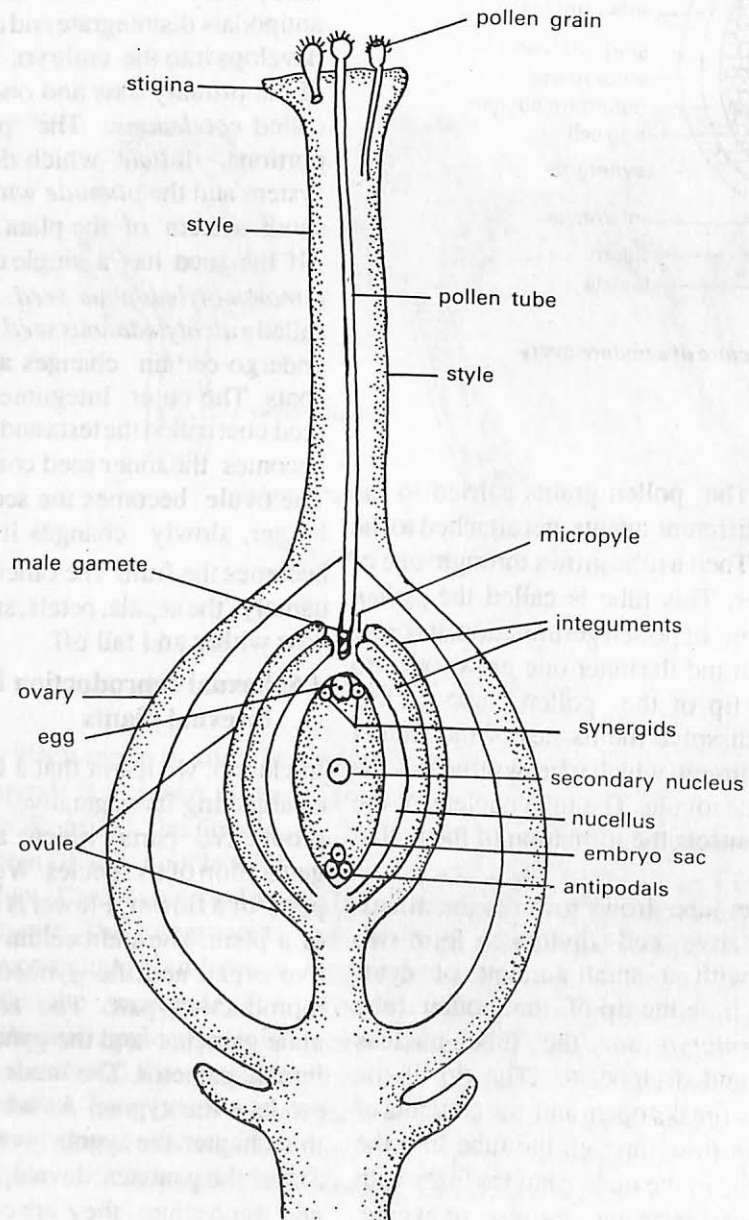


Fig. 4.44 Structure of the ovary at the time of fertilization.

CHANGES AFTER FERTILIZATION

PARTS IN A FLOWER	PARTS IN A FRUIT OR SEED
Pedicel	the stalk of the fruit
calyx, corolla, androecium	wither; sometimes the calyx is persistent.
Gynoecium	
stigma }	usually fall off but sometimes style is persistent.
style }	
ovary	fruit
ovary wall	fruit wall or pericarp
placenta	placenta
Ovule	seed
funicle	funicle
hilum	hilum
chalaza	chalaza
micropyle	micropyle
integument - outer	testa
integument - inner	tegmen
nucellus	often used up by the growing embryo.
Embryo sac	
Egg apparatus	
egg	zygote - later develops into embryo.
synergids	disintegrate.
secondary nucleus	after fertilization forms primary endosperm, nucleus and later forms the endosperm.
antipodals	disintegrate.

ent floral whorls in a bisexual flower. In some plants such as maize and coconut, they are produced in different flowers. Such flowers, having only one of the essential whorls, are called *unisexual flowers* which may be male or female depending on the type of the essential whorl it

has. In certain species, the male and female flowers are borne on separate plants, e.g., papaya. Such plants are called *dioecious plants*. If the male and female flowers are produced in the same plants, they are described as *monoecious plants*. The male and female gametes produced

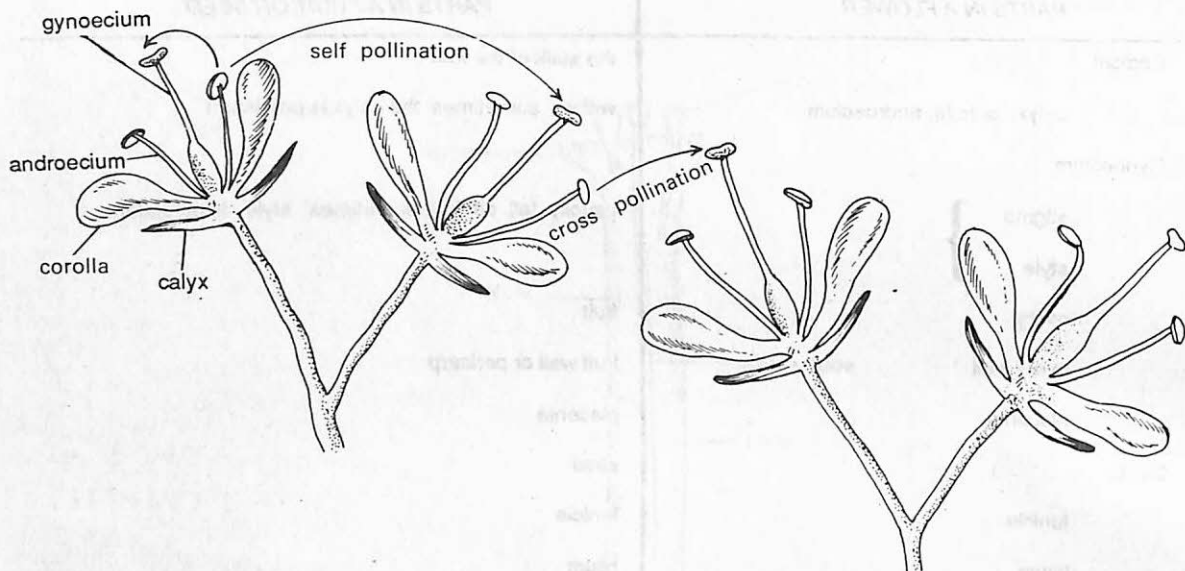


Fig. 4.45 Self pollination and cross pollination

in different reproductive whorls, sometimes far apart, must be brought together before fertilization. This bringing together of male and female gametes is accomplished by the process of pollination. Pollination may be defined as the transference of pollen grain from the anther to the stigma of a flower.

Pollination is of two types: *self-pollination* or *autogamy* and *cross pollination* or *allogamy*. In autogamy, pollen grains produced in the anther of one flower is transferred to the stigma of the same flower. In allogamy pollen produced in the anther of one flower is transferred to the stigma of another flower either on the same plant or on a different plant of the same kind.

Though self-pollination does occur in some flowers, nature seems to favour cross pollination. Cross pollination takes place in unisexual flowers.

Advantages of cross pollination: 1. The seeds

produced after cross pollination are bigger, more numerous and healthier.

2. During cross pollination, the characters of two parents are mixed, and a new variety is formed.

3. Frequent self-pollination results in the gradual deterioration of the plants.

Disadvantage of cross pollination: Plants have to depend on external agencies for pollination.

Adaptations or contrivances for cross pollination:

1. **Dicliny or unisexuality:** Cross pollination is possible only in a bisexual flower. In a unisexual flower, self-pollination is impossible.

2. **Dichogamy or ripening of sexes at different times:** In the bisexual flowers, it is only when the anthers and the stigma mature at the same time that self-pollination is possible. If they ripen at different times self-pollination is not

possible. If the anthers mature before the stigma matures, the condition is known as *protandry*, e.g., leucas, helianthus, hibiscus. When the stigma matures before the anther matures, the condition is called *protogyny*, e.g., wheat, paddy.

3. Self sterility: In some plants, the pollen has no effect on the stigma of the same flower. Only when it falls on the stigma of another flower, it will be effective, e.g., abutilon, passiflora.

4. Herkogamy: In many bisexual flowers, self-pollination is made impossible because of the position of the anthers and the stigma. The stigma may project far beyond the anthers or the anthers may be placed above the stigma. The stigma may be sticky and receptive only on the lower side as in *vinca*.

5. Pollen prepotency: The pollen from other flowers are more effective and grow more readily when deposited on the stigma of a flower than do the pollen from the same flower. This condition is common in many leguminous plants.

6. Heterostylism: In plants like oxalis and jaminum, some flowers have short styles and long stamens, while others have long styles and short stamens. The short styles and stamens are of the same length. Similarly, the long styles and stamens are of the same length. Because of this, the same part of the body of the insect that touches the anthers of the long stamens will also touch the stigma of a long style. Thus cross pollination is ensured.

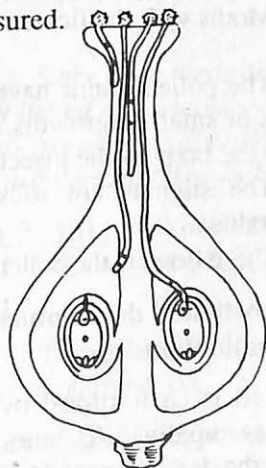


Fig. 4.46 Pollen grain germination

Agents for pollination: Pollination is brought about by certain agents. They are water, wind and insects.

1. Pollination by water (Hydrophily): This is not very common. This is seen in some of the submerged hydrophytes or water plants like *valisneria*, *hydrilla* and *elodea*. Plants are dioecious and submerged. Male flowers are produced in clusters and, when ripe, break off and come to the surface of the water. Each flower has three perianth parts and two stamens. The perianth parts curve back supporting the two stamens. The female flowers are produced singly on a long stalk. Each flower has an inferior ovary and three large stigmas. Surrounding each female flower there is a depression on the surface of the water. The male flowers come to this depression and shoot towards the female flower. The anthers break open and the pollen grains stick to the stigmas. After pollination the flower coils spirally and the fruit develops underwater. The pollen grains are light and float on the surface of the water.

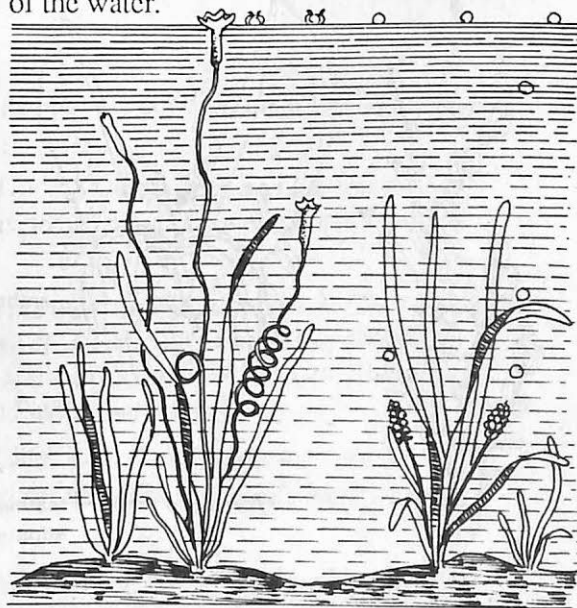


Fig. 4.47 Pollination in *valisneria*

2. Pollination by wind (Anemophily): This is an important pollinating agent and most of our

cereal producing plants and others such as palms produce flowers suitable for pollination by wind.

- a. The flowers are small in size with bright colours, honey and scent.
- b. They produce a large amount of pollen grains.
- c. The pollen grains are light and dry.
- d. The filaments are long and exserted and the anthers are versatile, so that they can swing freely on the filament, and the wind can carry the pollen grains easily.
- e. The stigmas are long and feathery, hanging out of the flower.
- f. Wind pollinated flowers are produced in inflorescences like spikes and catkins.
- g. In some wind pollinated plants, flowers are produced after the leaf falls so that the pollen may be carried by the wind easily.
- h. In certain grasses, the inflorescence grows well above the level of the leaves.
- i. In certain plants like pinus, the pollen grains are provided with wings.

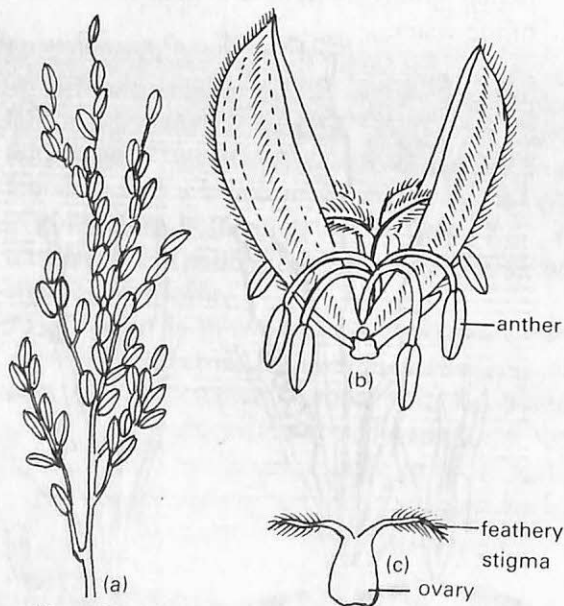


Fig. 4.48 (a) An inflorescence of paddy; (b) a single flower is enlarged to show the large pendulous anthers; (c) the pistil with the feathery bifid stigma.

3. Pollination by animals (Zoophily): The animals which bring about pollination may be either birds, slugs, squirrels, bats or insects. Pollination by insects is known as *entomophily*; pollination by birds is called *ornithophily*; pollination by bats is called *chiropterophily*; and pollination by snails is called *melacophily*.

a. Some entomophilous flowers are ideal places for the insects to lay their eggs and so they visit them, e.g. figs.

b. Insects come to the flowers for shelter in the night. The interior of the flowers is warmer than the surrounding atmosphere, e.g., aristo lochia.

c. The flowers offer food to the insects. Flowers offer pollen as food, e.g., anemone, or honey, e.g. saxifraga. Sometimes, as in orchis, the juicy cells of the spur offer sap for the insects.

d. Insect pollinated flowers are large in size, and are found as inflorescences.

e. These flowers are lightly coloured, e.g., *Canna indica*, *Mussaenda*.

f. Another attraction in these flowers is their scent, especially in those which bloom at night, e.g., *Cestrum nocturnum*. These flowers are white in colour and thus can attract insects even in the dark.

g. The flowers open depending on the kind of insects which visit them. Those which open during the day are visited by the butterfly and the moth. Moths visit the flowers of morinda in the night.

h. The pollen grains have rough and spiky surfaces or small outgrowths, and they easily get stuck to the body of the insect.

i. The stigmas are sticky to collect the pollen grains.

j. In these flowers the pollen output is limited.

4.7 Growth and development in plant seeds, germination

The seed is a fertilized ovule. It normally develops rapidly. As the seed ripens and matures the development of the embryo gradu-

ally ceases and the seed enters into a resting or dormant period, which lasts until the germinating season. Dormancy in seeds is probably meant to see them through unfavourable conditions such as drought, heat or cold.

Germination may be defined as a series of developmental processes that wake up the dormant embryo and transform it into a self-supporting seedling.

EXTERNAL CONDITIONS NECESSARY FOR GERMINATION

1. Water: Sufficient quantity of water is essential for germination. Water enters the seed through the micropyle and is absorbed through the testa. With the entry of water, the seed swells and its testa may break and vigorous physiological activities take place. Water is necessary for digestion, respiration and conduction of food.

2. Oxygen: Oxygen is needed to awaken the seeds to respire and to begin their physiological activities.

3. Temperature: Germination is affected by temperature. There is a minimum temperature to initiate germination, and a maximum temperature beyond which germination cannot take place. The best suited temperature for germination is called optimum temperature.

4. Light: In certain plants light is necessary for germination and in other plants light inhibits germination.

INTERNAL FACTORS NECESSARY FOR GERMINATION

1. Food and auxins: Seeds have reserve food in their cotyledons or endosperm. Germination is promoted by growth promoting substances like auxins.

2. Dormancy: Seeds should have a period of rest before germination.

3. Viability: The ability of the seed to germinate is called viability. Viability varies from seed to seed and from many days to many years.

Activity 11: A wad of cotton is placed at the bottom of each of the four test tubes, which are prepared as follows:

Test tube 1: Several bean seeds are placed on the cotton wool and the test tube is placed in a warm place. The seeds are thus provided with warmth and air but no water.

Test tube 2: Some bean seeds are placed on the wool and the test tube is filled with previously boiled and cooled water. A layer of oil is poured on top of the water. In order to prevent air dissolving in it the test tube is placed in a warm place and the seeds are thus supplied with warmth and water but not air.

Test tube 3: The cotton wool is moistened with water and the seeds are placed on top of it. The test tube is placed in a warm place, so that seeds have warmth, water and air.

Test tube 4: The set-up is similar to the previous set-up, but is placed in a cold place such as a refrigerator.

By observing the seeds from day to day you can find out the necessary conditions for germination.

Activity 12: Well moistened cotton wool is placed at the bottom of two glass jars, and maize grains are placed on top of the wool. A test tube containing pyrogalllic acid dissolved in sodium hydroxide solution is put into one jar, which is quickly corked and sealed with grease or wax. The other jar is also corked and sealed but is not provided with pyrogalllic acid solution. This solution has the power of absorbing oxygen from the air so that the seeds in the jar containing it cannot obtain any oxygen. The jars are placed in a warm place. Observe this day to day and record your findings.

THE STRUCTURE OF SEEDS

As far as the reproduction of the plant is concerned, the seeds are the most important structures. Essentially the seed is a baby plant with food reserves, and covered and protected by seed coverings. A study of a bean seed (dicot) and a maize seed (monocot) will help us to understand the structure of seeds in general.

The bean seed: Each seed is kidney-shaped and is protected by seed coats. The outer seed coat is called testa and the inner seed coat is called tegmen. On the concave side, there is a scar called hilum which marks the point of attachment of the seed to the wall of the fruit. On the upper

part of the hilum is a small opening called the micropyle. Through this the plants absorb water.

If the seed coats are peeled off, the two large cotyledons are revealed. These two cotyledons are attached to the primary axis. The primary axis has a rudimentary root portion called the radicle and a rudimentary stem portion called the plumule. The radicle and plumule together are known as the embryo. The tip of the radicle points towards the micropyle. The plumule is seen between the two cotyledons. It consists of a small bud having two tiny folded leaves. There is no endosperm in the bean seed, so it is described as a *non-endospermic* or *exalbuminous seed*.

Activity 13: Take a few bean seeds, soak them in water for a day. Observe the parts. Peel off the seed coats and observe the cotyledons, plumule and radicle. The plumule gives rise to the shoot system and the radicle to the root system.

Activity 14: Prepare a box with three compartments: A, B and C. Each compartment is fitted with a shutter on one side. Compartment A has a wooden shutter. Compartment B has a similar shutter but this shutter has a small opening in it. Light can pass through it into this compartment from one side. Compartment C has a glass shutter and a glass top. So this compartment can get light from all three sides.

Open the compartments and place a small pot with a sapling in each compartment and close them. Keep it in a well-ventilated room for a few days. The seedling in compartment A grows in darkness, the one in B grows with light incident only from one side. The one in compartment C grows with light incident from all sides. Observe and record the results.

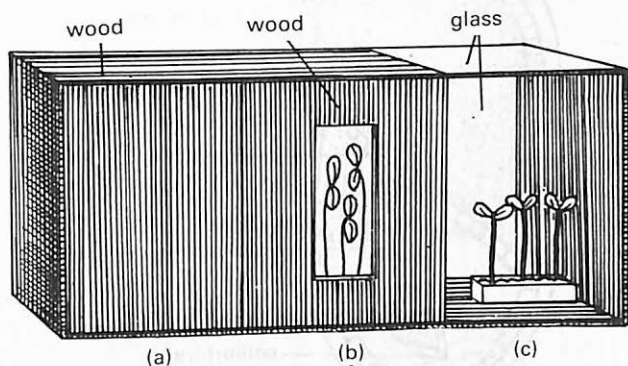


Fig. 4.49 Experimental setup to demonstrate effect of light on growth of main stems.

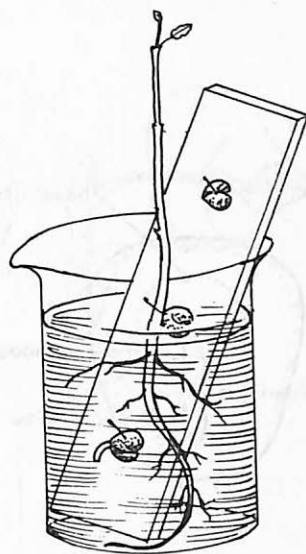


Fig. 4.50 The three seed experiment.

Activity 15 : Three bean seed experiment: Take three bean seeds and pin them to a wooden piece or a wooden ruler in such a way that one is in the middle and the other two at either end. Place the wooden piece in a beaker and pour previously boiled and cooled water into the beaker so as to keep the middle bean in contact with the water surface. Part of the middle seed is above the water surface. Leave this in a warm place and watch it daily and record any changes that you may observe. More water may have to be added from time to time to maintain the original level.

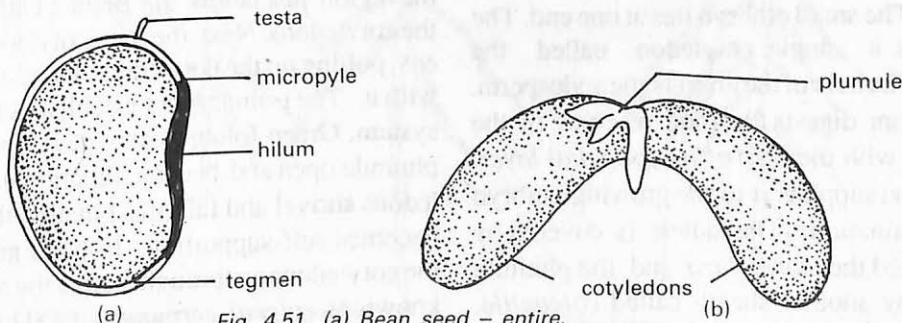


Fig. 4.51 (a) Bean seed - entire.
(b) Bean seed - cotyledons with embryo.

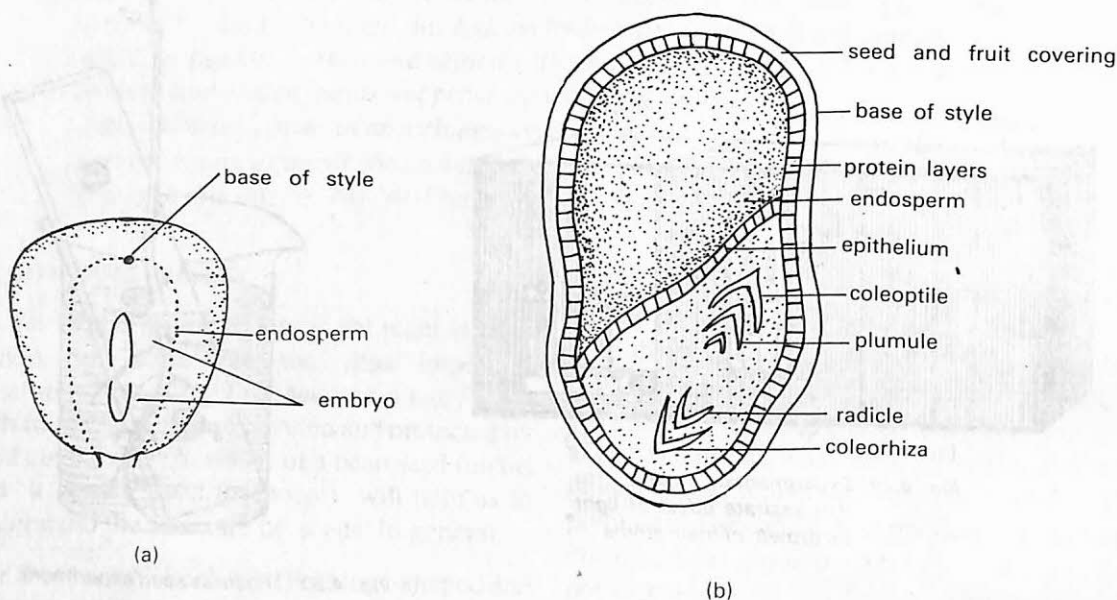
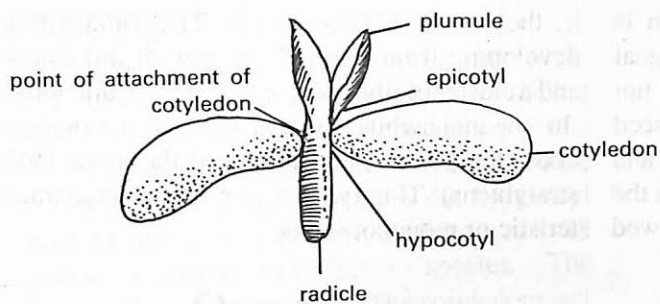


Fig. 4.52 (a) Maize grain – entire.
(b) L.S. of a maize grain.

The maize grain: This is a one-seeded fruit. It is a *caryopsis*. The pericarp and testa are fused. On one side of the grain is a whitish patch. Little above this is the remnant of the style. The seed is yellow in colour. Down the centre of the white patch runs a slight projection marking the projection of the plumule and radicle. If the grain is sliced longitudinally through the centre of this projection, its internal structure can be made out. The small embryo lies at one end. The embryo has a single cotyledon called the *scutellum*. The bulk of the grain is the endosperm. The scutellum digests the food reserves of the endosperm with the help of its *epithelial layer*, absorbs it and supplies it to the growing embryo during germination. The radicle is covered by a sheath called the *coleorhiza* and the plumule is covered by another sheath called *coleoptile*. The stored food consists mostly of starch with an outer layer of protein. This is an endospermic or

albuminous seed.

Germination of a bean seed: When the conditions necessary for germination are present, the seed swells up and the seed coat cracks. the radicle grows out to establish the primary root. This fixes the growing embryo to the soil. Now the *hypocotyl* elongates rapidly and forms a loop that may be seen above the ground. Hypocotyl is the region just below the point of attachment of the cotyledons. Next, the hypocotyl loop straightens, pulling up the cotyledons and plumule along with it. The primary root establishes the tap root system. Green foliage leaves developed from the plumule open and become functional. The cotyledons shrivel and fall off. Finally, the seedling becomes self-supporting. In bean germination, the cotyledons are brought above the soil. So it is known as *epigeal germination*. This type of germination is characteristic of dicotyledonous seeds.



An embryo of a bean seed.

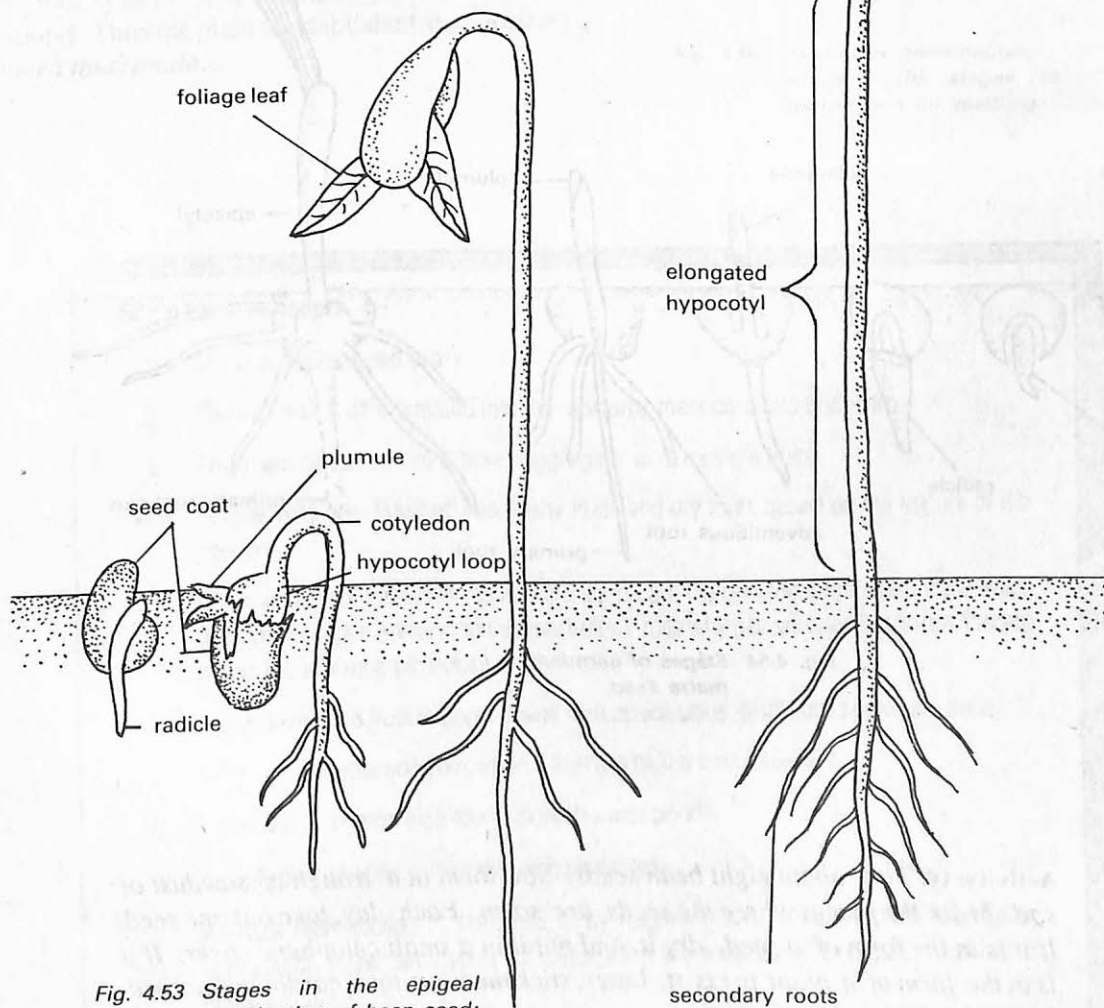
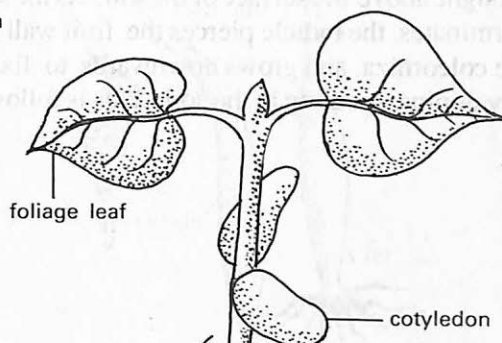


Fig. 4.53 Stages in the epigeal germination of bean seed;

secondary roots

Germination of the maize grain: Maize grain is an endospermic seed. This shows hypogeal germination. Here the cotyledons are not brought above the surface of the soil. As the seed germinates, the radicle pierces the fruit wall and the coleorhiza, and grows downwards to fix the developing seedling in the soil. This is followed

by the growth of the coleoptile. The primary root developing from the radicle soon disintegrates and a cluster of fibrous roots take up its functions. In the meanwhile, the epicotyl (the region just above the point of attachment of the cotyledons straightens). This type of germination is characteristic of monocot seeds.

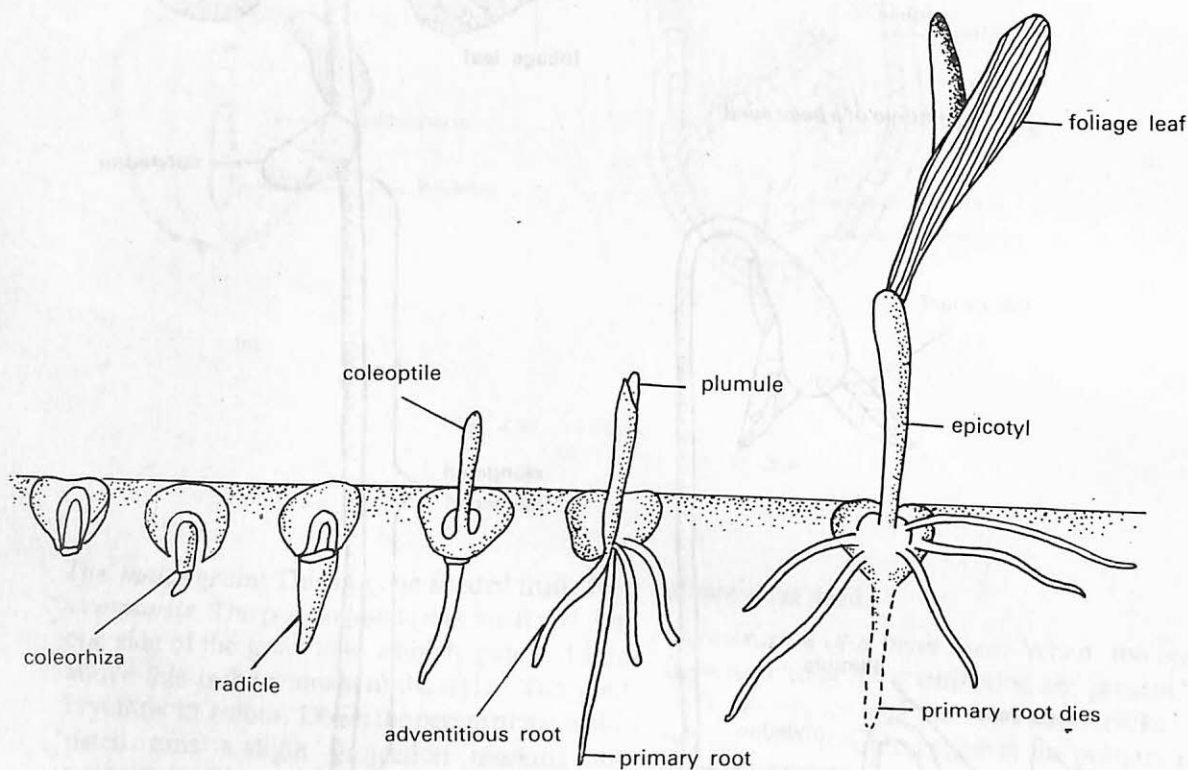


Fig. 4.54 Stages of germination in a maize seed.

Activity: 16 Take about eight bean seeds. Sow them in a trough of sawdust or soil. Mark the places where the seeds are sown. Each day, take out one seed. If it is in the form of a seed, dry it and put it in a small cellophane cover. If it is in the form of a plant press it. Later, stick them on to a cardboard according to the days.

VIVIPARY

Germination of the seed within the fruit while still attached to the mother plant is called *vivipary*, e.g., coconut. In the mangrove plants the seed grows inside the fruit. First, the radicle comes out of the fruit and then the hypocotyl begins to grow. It may grow to a length of 2–18 inches, according to different species. The hypocotyl has a sharp end. The cotyledons act as haustoria and the plumule grows. When the hypocotyl becomes heavy, the fruit gets detached from the plant and falls vertically downwards. the radicle penetrates the soil and forms the root system. The plumule grows above the ground. Thus the plant is established, e.g., *Rhizophora mucronata*.

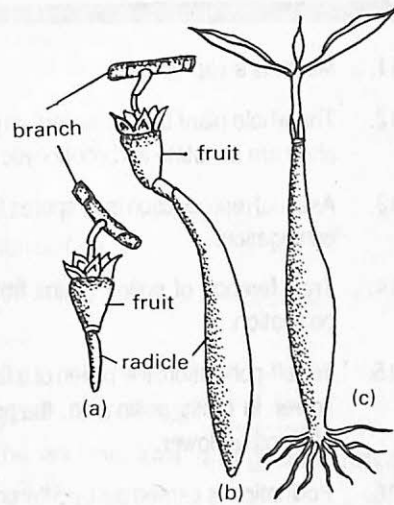


Fig. 4.55 Viviparous germination (a) and (b) stages in germination (c) seedling.

Some basic concepts

1. The fruit is a matured ovary.
2. The fruit wall is differentiated into the epicarp, mesocarp and endocarp.
3. Fruits are classified into simple, aggregate and multiple fruits.
4. Simple fruits are classified into fleshy fruits and dry fruits based on the texture of the pericarp.
5. Dry fruits which break open to liberate seeds are dry dehiscent fruits and fruits which do not break open are dry indehiscent fruits. Fruits which break open but do not liberate seeds are schizocarpic fruits.
6. Fruits developed from a single flower with apocarpous pistils are aggregate fruits.
7. When the inflorescence becomes a fruit it is called a multiple fruit.
8. Spirogyra is a green alga found in fresh water ponds.
9. It has spiral-shaped chloroplast with pyrenoids.
10. Asexual reproduction in spirogyra is by fragmentation. Sexual reproduction is by conjugation. The two types of conjugation are scalariform conjugation and lateral conjugation.

11. Mucor is a saprophyte.
12. The whole plant body is called mycelium which consists of a number of hyphae. Hyphae are aseptate and coenocytic.
13. Asexual reproduction is by spores formed in the sporangium. Sexual reproduction is by conjugation.
14. Transference of pollen grains from the anther of a flower to the stigma is called pollination.
15. In self-pollination, the pollen of a flower may be deposited on the stigma of the same flower. In cross pollination, the pollen of one flower may be deposited on the stigma of another flower.
16. Pollination is carried out by different agents—water, insects or wind. Accordingly each group of flowers have certain adaptations.
17. Pollen grains produce the male gametes and the ovule produces the female gametes.
18. Fusion of male and female gametes is called fertilization.
19. After fertilization, the ovary becomes the fruit, ovary wall the fruit wall, ovule the seed, and integuments the seed coats.
20. Germination is a series of developmental processes that wake up the dormant embryo and transform it into a self-supporting seedling.
21. Factors influencing germination are water, light, oxygen, temperature, food and auxins, dormancy and viability.
22. There are two types of germination, epigeal and hypogeal.
23. Bean seed is an example of a non-endospermic or exalbuminous seed and maize is an endospermic or albuminous seed.
24. In the bean seed the embryo is embedded in the cotyledons. In the maize grain the embryo is found at one end of the grain. The embryo is called the scutellum.

REVISION TIME

I. Fill in the blanks:

1. The whole plant body of mucus is called _____.
2. Spirogyra has a _____ chloroplast.
3. The multinucleate condition in mucus is called _____.
4. In the apple, the edible part is the _____.
5. Datura is an example of _____ capsule.
6. Plants which complete their life cycle in two years are called _____.
7. When there is a difference in the heights of the androecium and gynoecium of a flower, it is described as _____.
8. The fruits which do not open to liberate the seeds are called _____.
9. The plumule and the radicle together form _____.
10. The part of the flower which becomes the fruit is the _____.
11. An example of a multiple fruit is _____.
12. Pollination by birds is called _____.
13. Radish is a _____.
14. In a berry the epicarp is _____.
15. The inner covering of a bean seed is called _____.

II. Define the following:

1. Fertilization
2. Pollination
3. Multiple fruit
4. Sporangia
5. Scutellum
6. Double fertilization
7. Vivipary
8. Vegetative reproduction

III. Distinguish between the following:

1. Endospermic and non-endospermic seed
2. Epigeal and hypogeal germination
3. False fruit and true fruit
4. Protandry and protogyny

5. Nutrition in spirogyra and mucor
6. Autogamy and allogamy
7. Coleoptile and coleorhiza
8. Achene and caryopsis
9. Sporophyte and gametophyte
10. Mango and coconut
11. Follicle and legume
12. Annual and perennial

IV. *Answer the following:*

1. Explain the scalariform conjugation in spirogyra.
2. Describe the structure of mucor.
3. Describe the structure of spirogyra.
4. Describe a non-endospermic seed.
5. Describe the mechanism of fertilization after pollination has occurred.
6. List the characteristics of wind pollinated flowers.
7. Mention the changes in a flower after fertilization.
8. Write notes on:
 - a) embryo sac, b) pollen grain
9. Explain the vegetative reproduction methods in nature.
10. What are the essential conditions for the germination of a seed?

V. *Choose the correct answer:*

1. Which of the following characteristics is seen in wind pollinated flowers?
 - a. large open flowers
 - b. no scent or nectar
 - c. feathery protruding stigma
 - d. heavy sticky pollen grains
2. In a monoecious plant,
 - a. the male and female parts are borne by the same plant but not by the same flower.
 - b. the male, female and neuter parts are borne by the same plant.
 - c. the male and female parts are borne by different plants but not by the same flower.
 - d. the male and female parts are borne by the same flower.
3. The production of new plants without seeds is termed as
 - a. sexual reproduction.
 - b. vegetative reproduction.

- c. fertilization.
 - d. none of the above.
4. Pollination means
- a. the same as fertilization but is applied only to plants.
 - b. the shedding of pollen from the anther.
 - c. the dispersal of pollen by wind or insects.
 - d. the transfer of pollen from anther to stigma.
5. The transference of pollen from anther to the stigma of another is known as
- a. autogamy.
 - b. allogamy.
 - c. homogamy.
 - d. cleistogamy.
6. The pod of pea is a
- a. fruit.
 - b. vegetable.
 - c. modified leaf.
 - d. seed.
7. A simple fruit develops from
- a. apocarpous pistil.
 - b. parthenocarp.
 - c. single ovary of a single flower.
 - d. the carpel where there are many free ovaries.
8. The outer cover of the pollen grain is
- a. intine.
 - b. exine.
 - c. integument.
 - d. testa.

VI. Draw and label the diagrams for the following:

1. Various stages in the germination of a bean seed.
2. The structure of a mature ovule.
3. The structure of spirogyra.
4. Asexual reproduction in mucor.
5. Any two fleshy fruits.

5. Organisms and environment

agricultural practices and implements - preparation of soil - selection of seeds, sowing and transplanting - weeding - manuring - irrigation - crop protection - harvesting and threshing - storage - conservation of natural resources - non-renewable and renewable resources - conservation of water - soil erosion - Vanamahotsava and Chipko Movement.

Early man was a predator, a prey to other predators and a host for parasites. This ecological relationship of man and his environment began to change, slowly first and later rapidly when he became a farmer. Crops provided increased food supply. This resulted in increase in human population. Animal power was harnessed. Man became more and more independent and gradually became the maker of communities. With science and technology, he began to change the ecosystem. He began to obtain control over the parasites which cause diseases.

Later, industrialisation created man's own artificial ecosystem—the cities. Green areas are being destroyed and in their place concrete structures are being erected, changing the whole landscape. Meadows and other vast areas are paved with concrete in order to build highways, dams and aerodromes. Consequently the water balance of the biosphere and the equilibrium of nature have been disturbed.

The only solution to these problems is to recognise that man and his environment are inseparable parts of the same ecosystem in which he is bound to every other organism.

5.1 Agricultural practices and implements

The improvement of land and irrigation facilities for the cultivation of useful plants on a large scale is known as *agriculture*. In order to get high yielding, disease-resistant and better quality crops, various new scientific methods are followed.

5.2 Preparation of soil

Before any seed is sown for cultivation, the soil has to be prepared first. There should be an easy penetration of roots through the soil to get water and mineral salts. The soil is therefore turned over by a few inches to facilitate aeration. This is known as *ploughing* or *tilling*. This process helps the roots to penetrate deeper into the soil and get enough oxygen.

Ploughs used for tilling are made of wood and iron and are driven by animals. Nowadays farmers use tractors to plough their fields. The ploughs are chosen according to the type of soil. If the soil is hard, the plough must have sharp iron to break it. When the soil is dry, it breaks into big chunks. These have to be further broken down by *clod crushers*. After the soil or land has been

tilled, the top soil may get eroded by wind and water. To prevent this the soil is levelled with wooden levellers. By doing this, water distribution

is facilitated. Preparation of soil is also helpful for its productivity. If a land is cultivated continuously, it may lose its fertility.

Activity 1: Prepare a plot for gardening.

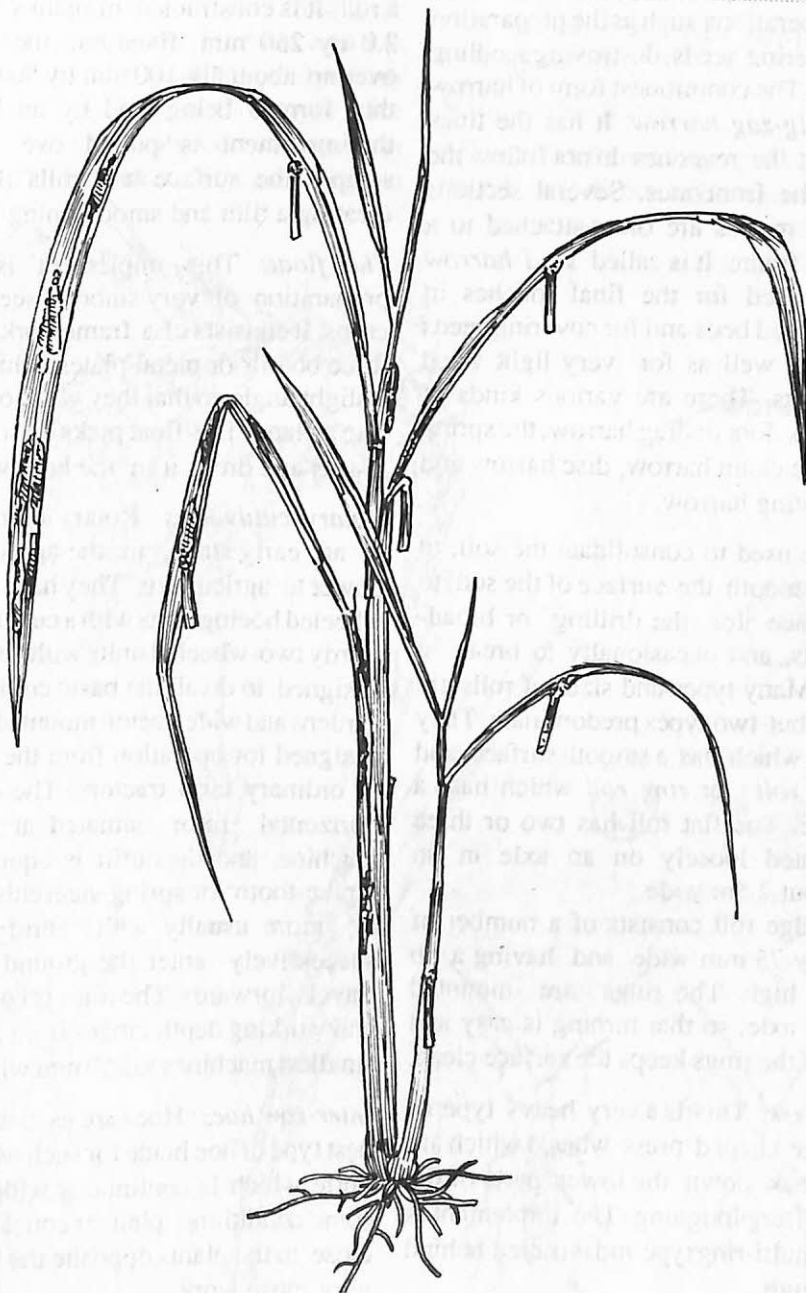


Fig. 5.1 Paddy plant

Activity 2: Visit a crop field and find out all the agricultural practices and implements used. Give suggestions for improvement.

TILLAGE IMPLEMENTS

Harrows: Harrows are generally used for shallow cultivations in operations such as the preparation of seed beds, covering seeds, destroying seedling weeds and so on. The commonest form of harrow is called the *zig-zag harrow*. It has the tines staggered so that the rear ones do not follow the same tracks as the front ones. Several sections totalling 4.5 – 6 metres are often attached to a tractor-mounted frame. It is called *seed harrow* because it is used for the final touches in preparation of seed beds and for covering seeds after the drill, as well as for very light weed control operations. There are various kinds of harrows like duck-foot or drag harrow, the spring tined harrow, the chain harrow, disc harrow and rotary reciprocating harrow.

Rolls: Rolls are used to consolidate the soil, to crush clods, to smooth the surface of the soil, to prepare a surface for the drilling or broadcasting of seeds, and occasionally to break a surface crust. Many types and sizes of rolls are used on farms, but two types predominate. They are the *flat roll*, which has a smooth surface, and the *cambridge roll* or *ring roll* which has a ribbed surface. The flat roll has two or three sections mounted loosely on an axle in an implement about 2.5m wide.

The cambridge roll consists of a number of rings, generally 75 mm wide and having a rib about 37 mm high. The rings are mounted loosely on an axle, so that turning is easy and intermotion of the rings keeps the surface clean.

The furrow press: This is a very heavy type of roll with wedge-shaped press wheels which are designed to break down the lower parts of the furrow slices after ploughing. The implement is generally of a multi-ring type and is trailed behind the tractor plough.

The planker or scrubber: This is used for breaking down clods on land where it is impossible to use a roll. It is constructed of planks approximately 2.0 by 250 mm, fixed together so that they overlap about 50–100 mm by 50 mm, the corner thus formed being shod by an iron bar. When the implement is pulled over the ground, it scrapes the surface and rolls the clods over, creating a tilth and smoothening the top.

The float: This implement is used in the preparation of very smooth seed beds for root crops. It consists of a framework carrying two or three boards or metal plates, which can be set at a slight angle so that they work on the soil rather like a plane. The float picks up soil from the high places and drops it in the hollows.

Rotary cultivators: Rotary cultivators are used at an early stage, in the application of steam power to agriculture. They have very small two-wheeled hoeing units with a cut of about 250 mm, sturdy two-wheeled units with engines of 5–8 h.p. designed to do all the basic cultivations in small gardens and wide tractor-mounted or trailed outfits designed for operation from the power take-off of ordinary farm tractors. The engine drives a horizontal rotor situated at the rear of the machine, and the outfit is equipped either with 'spike-tooth' or spring-steel chisel-shaped tines, or more usually with sturdy hoes which successively enter the ground as the machine travels forwards. The rotor is covered by a hood, and working depth ranges from 100 mm with the smallest machines to 250 mm with larger models.

Inter-row hoes: Hoes are used to kill weeds. The best type of hoe blade for such work has a vertical knife which is continuous with the L-blade. In some conditions, plain or concave discs running close to the plants opposite the L-blades permit very close work.

TRANSPLANTING MACHINES

Transplanting machines include a simple type with which the operator sits very near the ground and places the plants directly into a furrow opened by the planter. A pair of inclined press wheels follows and firms the soil around the plant roots. An intermediate type has a pair of driven rubber discs to grip the plants and convey them into the furrow. In another type the operators place the plants on an endless conveyor belt. The belt takes the plants down to

a furrow which is opened by a machine and releases them as the press wheels firm the soil alongside.

5.3 Selection of seeds, sowing and transplanting

SELECTION OF SEEDS

After the land has been prepared, seeds are selected for growing. Seeds to be sown must be free from

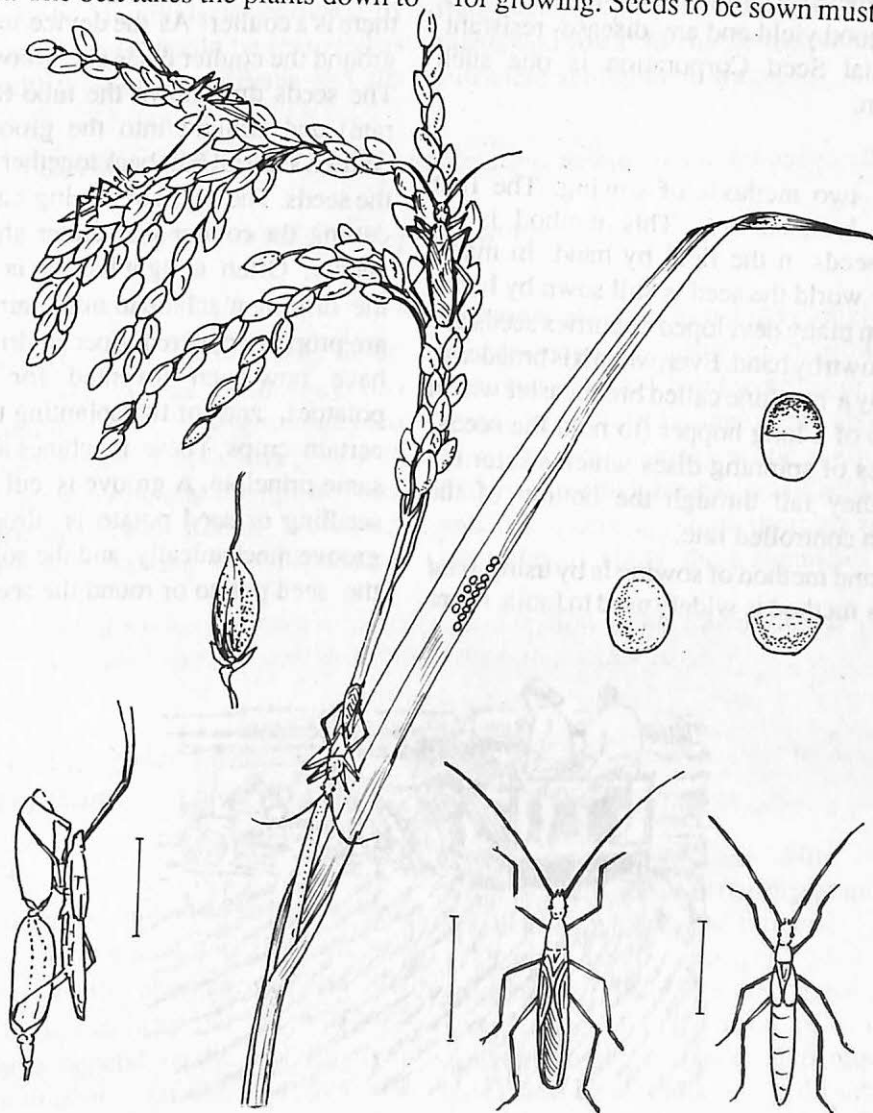


Fig. 5.2 Rice plant

diseases and also resistant to diseases. The seeds should be viable for germination. The seeds should be obtained from a healthy plant. Seed treatment with fungicide is essential to check the spread of seed-borne diseases. The seeds are treated with chemicals like Agrosan or Ceresan. This treatment also protects the seedlings from the attack of many diseases. There are agricultural research institutes where good quality seeds are raised for distribution to the farmers. Crops raised from these seeds are of high quality as they provide a good yield and are disease-resistant. The National Seed Corporation is one such organisation.

SOWING

There are two methods of sowing. The first method is *broadcasting*. This method is by scattering seeds in the field by hand. In many parts of the world the seed is still sown by hand. However in many developed countries seeds are no longer sown by hand. Even when it is broadcast, it is sown by a machine called broadcaster which is made up of a long hopper (to hold the seeds) and a series of spinning discs which scatter the seeds as they fall through the bottom of the hopper at a controlled rate.

The second method of sowing is by using *seed drills*. This method is widely used in India. More

often nowadays seeds are sown in drills (rows) and there are machines to do this, too. The simplest seed drill consists of a vertical tube with a seed bowl. This arrangement is tied to the plough and the farmer drops the seeds into the bowl as the plough drags on the seed drill. The country plough is often adapted to line sowing. There are a number of modifications in the seed drill. The principle in all is the same.

There is another type where the seeds are contained in a hopper. Just in front of the hopper there is a coulter. As the device moves along the ground the coulter discs cut grooves in the soil. The seeds drop down the tube (at a controlled rate) and straight into the groove cut by the coulter. The soil falls back together again covering the seeds. The depth of sowing can be varied by cutting the coulter slits either shallow or more deeply. Often a light harrow is pulled behind the drilling machine to make sure that the seeds are properly covered. Special drilling machines have now been invented for planting seed potatoes, and for transplanting the seedlings of certain crops. These machines also work on the same principle. A groove is cut in the soil, the seedling or seed potato is dropped into the groove mechanically, and the soil is firmed over the seed potato or round the seedling again.



Fig. 5.3 Mechanised transplanting

TRANSPLANTING

In the cultivation of paddy and many vegetables, the seeds are first sown in a nursery bed and only after a certain stage they are transplanted to the main field. The seed bed is properly ploughed and prepared so that it is soft and loose enough to permit the growth of the tender roots. The level of the seed bed is kept uniform in order to ensure uniform distribution of irrigation water. Frequent and right irrigation in the nursery is very essential as the plants at this stage are more likely to dry up than the adult plants. The soil is pre-enriched by applying manure. Weeds should be removed as they compete with the crop for nutrients and sun

light. Seedlings must be protected from diseases and pests by spraying of chemicals like Parathion, Sevin, Dimercron, Thiodon and Rogor.

The practice of taking the seedlings from the nursery to the main field is known as *transplanting*. Transplanting allows better penetration of roots in the soil and better shoot development. Transplanting is a common practice in rice and many vegetables. The main field is appropriately ploughed and manured. When the seedlings are 4–5 leaved, transplanting is done. During the transplanting, proper distance is kept between plants and rows to enable the plants to receive sufficient sunlight and water.

Activity 3: Sow some green seeds by the broadcasting method in the school garden.

Activity 4: Observe sowing of seeds and transplanting.

5.4 Weeding, weedicides

Weeds are the undesirable plants in crop fields. Weeds are classified as *graminaeous* (monocotyledonous) and *non-graminaceous* (dicotyledonous) weeds. Weeds compete with the crop plants for nutrients and sunlight and thus grow at the expense of crop plants. Weeds are first removed before sowing or transplanting,

by hand weeding or by using a plough or harrow. Weeds reappear during crop growth and are removed either by hand weeding or by spraying weedicides (weed killing chemicals) like 2,4-D (2,4 - Dichlorophenoxy acetic acid) MCPA (4 - Chloro -2 methylphenoxy acetic acid), Simazine, and Tok. There are some spraying appliances in use today to apply these chemicals.

Activity 5: Visit the school garden or a house garden. Sow some tomato seeds in a small plot (prepared earlier) and transplant them to another area.

Activity 6: Visit fields, farms and nurseries and find out weed control measures adopted by them.

5.5 Manuring

Plants can synthesise complex organic substances utilising simple inorganic factors from the soil and atmosphere. In the absence of these, the plant will not be able to carry out the metabolic activities. Plants depend on the soil for their nutrients. Continuous farming on the land exhausts the mineral nutrients in the soil. The

soil should be enriched with manure and fertilisers. This is one of the important agricultural practices adopted by the farmers.

Plants need *nitrogen*, *phosphorus* and *potassium* in plenty for their growth. These are added to the soil in the form of NPK fertilisers. Apart from these, plants also require macro-nutrients like carbon, hydrogen, oxygen, calcium, magnesium, sulphur and iron. They

also require the micro-elements like manganese, copper, zinc, boron, molybdenum and chlorine. Other fertilisers which may be added are CAN fertilisers which consists of calcium, ammonium nitrate, urea, superphosphate, etc.

Continuous cultivation of crop plants depletes the nutrient content of the soil. This can be set right by adding suitable fertilisers. Leaching by rain water and soil erosion reduce the nutrient content of the soil.

Growing a leguminous crop enriches the soil with nitrates. Bacteria in their root nodules convert the nitrogen into nitrogen compounds which enrich the soil.

MANURES

Manures are organic materials which supply all the elements a plant needs in small amounts. Besides serving as a source of nutrients, organic manures improve the physical condition of the soil.

There are five important types of manures. They are farmyard manure (FYM), compost, green manure, sea manure and poultry manure.

Farmyard manure: It is the most valuable organic matter commonly applied to the soil. Even the poorest farmer can provide this manure to the soil. This usually consists of remnants of straw, leaves and other materials like the excreta of cattle. Cow dung is to be properly stored in a pit. It is necessary to dig the pit in the shade and keep the dung moist. When the content is raised above ground level, the surface becomes plastered with mud. The manure becomes ready after 4-5 months. Farmyard manure is usually loaded into a trailer with built-up sides, a moving floor and a shredding device at the rear. This device shreds the manure and scatters it as the tractor pulls the trailer across the land.

Green manure: A quick maturing crop is raised and ploughed into the field. This benefits a succeeding crop. Leguminous crops like cluster beans, cowpea, horsegram, etc. are grown as green manure crops.

Composts: This consists of all the cattle shed wastes and all the available refuse from the house. These include straw, farm weeds, vegetable refuse, groundnut husk and other substances. All these are properly mixed together and can be used as manure after *rottening*. This is known as rural compost. Presently, the municipalities are composting waste materials from cities.

Poultry manure: This is extremely rich in plant nutrients and is used sparingly.

Sea weed: This has been used as manure by people who live close to the sea since the beginnings of agriculture. It has about the same value as farmyard manure.

Other manure: Many different sorts of waste matter are also used as manure. The most common of these are sewage, sludge, dried blood, hair, ground hoof and horn, spent hops and damaged oil cakes. The value of these different manures varies greatly from batch to batch.

FERTILISERS

Fertilisers are generally grouped as

1. nitrogenous fertilisers,
2. phosphate fertilisers, and
3. potassium fertilisers.

Fertilisers furnish the available nutrients to the plants. In recent years, attention is being paid to the application of various macro- and micro-nutrients.

In some cases, the weedicides and micro-nutrient sprays are combined. The following are some of the fertiliser compounds usually available.

Nitrogenous fertilisers - ammonium sulphate, ammonium nitrate, urea.

Phosphate fertilisers - superphosphate, bone meal, rock phosphate.

Potassium fertilisers - muriate of potash (KCl) sulphate of potash (K_2SO_4)

The NPK fertilisers are available as mixed fertilisers. These are now manufactured by different companies in India. Specially mixed fertilisers are available for different crops. Fertilisers added in excess can cause great harm to the plants. Adequate soil moisture is essential after the fertiliser is applied. Application of fertilisers is more effective with good irrigation or in regions with assured rainfall.

Fertilisers usually come in a dry form, either as a powder or as crystals or pellets. These fertilisers are spread on the ground by means of a long,

wide box or hopper, which lets the fertiliser fall to the ground at a controlled rate. Very often the hopper is used together with a seed drilling machine so that the fertiliser and the seeds are dropped together. Alternatively, the fertiliser can be loaded into an inverted cone-shaped hopper. As the fertiliser runs out of the bottom of the cone it is scattered on the land by a spinning disc. This scatters the fertiliser far and wide, but it is difficult to be sure how much fertiliser has been applied and at what rate. This device is usually used for spreading lime or slag.

Activity 7: *Observe manuring of plants in your school garden or at home.*

5.6 Irrigation, watering, percolation of water, logging, drainage, seepage, furrow irrigation and basin irrigation

IRRIGATION

Irrigation is the artificial application of water to the land. For the survival and proper development of plants, irrigation is necessary. Roots fail to develop and elongate in dry soil. The crop is irrigated according to its water requirement and soil characteristics. Irrigation practices in cereals thus vary for different types of crops and soils. Irrigation is essential during the seeding, tillering, flowering and grain filling stages of the crop. There should be provision for draining excess rain water. The rice plant tolerates standing water in the field while in others like maize and vegetables, excess water must be properly drained out. Heavy rains during the harvest season of cereals cause crop losses. Three main types of irrigation are practised in India. They are described below.

1. Wells: This is a very old method of irrigating a field. An ordinary well is easy to dig and construct. It dries up during the dry season and can irrigate only a small plot of land. A tube well is more costly but can irrigate about 400 acres of land. Electricity is a must for tube wells.

2. Tanks: A tank has a non-porous rock structure at the bottom and a masonry wall on one or more sides to check the outflow of water towards the slope. During the rainy season the water gets collected and the same water is supplied to the neighbouring fields during the dry period.

3. Canals: The most important type of irrigation in India is canal irrigation. Canals are generally of two types: a. inundation canals, and b. perennial canals.

a. **Inundation canal:** These canals are taken out from the rivers without constructing any sort of dam or barrage. Therefore they are full only during the rainy season when rivers are in full spate. They are, in fact, of little use because they cannot supply water during the dry period.

b. **Perennial canal:** These are taken out from rivers or artificial reservoirs. In order to keep them full, embankments, dams or barrages are constructed across the streams so that water is available for these canals even during the dry season as the rainwater is stored in the dam and extra flow of water is checked. Perennial canals must have uniform level, so that the water flows smoothly. For this purpose, embankments have to be constructed wherever the surface slopes down. If the land is slightly higher, the canal has to be carried further through cuttings and

tunnels so as to maintain the level for the steady flow of water.

WATERING

The two main methods used by the cultivator for watering the land are damming streams and lifting water from rivers and wells by water-wheels or gear operated by hand or other means. The water-wheel is designed to lift water from a river or well to irrigate the land.

The Persian water-wheel and the shadoof are two ancient and primitive methods of lifting water for irrigation. The Persian water-wheel has wooden teeth on the outer rim, mounted on a vertical shaft, from the upper part of which projects a horizontal arm, to which are yoked two bulls. This wheel drives a similar but smaller wooden toothed wheel, mounted on a horizontal shaft, the other end of which carries a large open-spoked wheel with a wide periphery. The latter carries two parallel endless ropes, joined by spacing bars, to which are attached a series of water containers. The loop of the parallel ropes dips into the water and as the wheel revolves, the filled containers are carried to the top of the wheel, where they spill their contents into a trough. From the trough the water flows into the field. This water wheel can raise water to eight metres.

The shadoof consists of two posts supported by a cross bar on which is pivoted a long wooden lever, to the shorter end of which is fixed a weight to act as a counterpoise to a rod or rope and dipper attached to the long arm. The rod is seized high up and pulled down until the dipper enters the water. The filled dipper is then allowed to rise, pulled by the counterpoise weight, until it reaches the level of a trough or channel into which it empties the water which flows into the field.

Another common method is by means of a locally made foot-pedal machine, light enough to be carried by one man from one terrace to another. It is built of wood, bamboo and paddy straw rope. It has a long, narrow wooden trough, 20 to 40 feet long, about one ft. wide and one ft. deep. Moving up this trough is part of a wood and paddy straw circular chain with paddles that fit into the trough at every foot. The circular chain is attached to a roller on the upper end by means of wood gears, and on the roller there are several foot rests. Power, when applied to these footrests, turns the roller which moves the circular chain up the trough, pulling water from the lower terrace or stream to the field to be irrigated.

Small saplings should be watered very carefully. Water should be gently sprinkled on them. Slightly bigger plants can be watered with the help of a hose pipe.

Activity 8 : Visit a field and find out the methods of irrigation used there.

PERCOLATION

If more water falls than can be retained by the soil, the surplus moves downwards under the influence of gravity, provided there is no obstacle for percolation. The characteristic of the soil which determines the extent to which this can take place is called 'permeability' and it depends on the structure and texture of the soil mass and of the underlying geological material. If this is coarse and open, as in the case of soil lying on

deposits of gravel or sand, the water can move downwards through the large interspaces with ease. If on the other hand, the soil mass consists chiefly of the finest mineral particles, as in the case of clay, water cannot percolate through it easily. Such material can only attain a measure of permeability as a result of the channels made by earthworms or decaying roots. These particles are colloidal in nature and display a marked degree of shrinkage on drying and of swelling on

remoistening. The broad effects in field conditions are *fissuring* of the ground in summer, and splitting of the clay soil into structural units with a network of interspace amongst them which persists somewhat even after remoistening and swelling.

WATERLOGGING

This is a serious problem which has rendered extensive areas along the canals unfit for farming. The canals are generally unlined, therefore water seepage towards adjoining areas goes on, turning them into swamps and rendering them unfit for cultivation. Waterlogging can arise from two causes. In otherwise permeable geological formation, it will be liable to waterlogging if the depth to the obstructing material is only a metre or two.

The other cause is that while percolation is mainly a vertically downward movement, the resulting body of ground water moves in a different fashion influenced by the shape of the impermeable floor on which it rests and the differences which arise in hydrostatic pressure.

For solving the problem of waterlogging, it is necessary to line the canals with brick and mortar along the embankment. Wells may be dug in the waterlogged areas, so that the water soaks down into these wells. By using gypsum, the waterlogged areas can be made fertile again. Swamps may be dried by draining out water with the aid of power driven pumps.

DRAINAGE

The purpose of drainage is to improve agricultural soils by removing any surplus water from them. All soils are porous. This means that they absorb a certain amount of rain water, while the rest naturally filters through the soil and drains away. However, if more water falls than the soil can absorb or drain, then the soil becomes waterlogged. The water then prevents oxygen from reaching the roots of plants, and the plants 'drown'. If still more water falls, particularly on land that slopes, there is a real danger of the soil

itself being washed away. Poorly drained soils are slow to warm up in spring, and they are very difficult to cultivate. If such land can be drained, it will be far easier to cultivate, it will warm up more quickly in spring, the plants will grow better, and the crop will ripen sooner.

In the normal course of events, all the water that falls on the soil, except for the proportion that is evaporated and the rest that is used by the plants for their growth, drains away into streams, rivulets, and rivers. Drains are built to help the surplus water reach these streams more quickly. There are three types of field drains — *open furrows*, *ditches* and *covered pipes*.

The open furrow system is very simple. The land is ploughed so that the furrows slope gently downwards, allowing surface water to drain away. If the furrows slope too steeply, the soil will be washed away. This system only works on land that slopes naturally.

Ditches are dug round the sides of fields to collect the drain water. These can be used on fairly level ground, since the bottom of the ditch can be sloped to carry water away. The chief disadvantage of ditches is that they occupy land that could be used for crops.

The covered pipes system is regarded as the most satisfactory method of draining farmland. The pipes are made of hollow tubular tiles. They are porous and allow water to filter through them on the inside. The tiles are laid end to end, and the surplus water drains away along them. The pipes are set in the soil at a depth 2–4 feet. They are arranged in such a way that smaller pipes feed larger ones. They can be laid by machines, and they give an effective drainage system for 10–15 years.

SEEPAGE

Seepage varies widely according to soil characteristics, topography, depth of ground water-table and farming practices. While seepage has certain advantages, such as removal of toxic

excessive seepage results in wastage of water, leaching of plant nutrients, waterlogging and soil salinity. A measure of restriction of seepage may be achieved by puddling the soil or by spreading mud over the field surface, by using heavy rollers, adding clay to sandy soil, addition of bentonite or by using plastic film sheeting on the subsoil or mixed with the surface soil.

BASIN IRRIGATION

This is an ancient and simple method of adding water to the land and is especially common on the flood plains. Great quantities of rich silt and water were impounded in small basins enclosed by low mud walls. This water could be moved from one basin to another by opening gaps in the mud walls. As the river subsided, and the excess water drained back into the main river channel, crops of cereals and vegetables were planted in the rich damp mud.

5.7 Crop protection — pest, pesticides

ANIMAL PESTS OF CROP PLANTS

Various animals cause considerable damage to the crops and cause severe crop losses. These losses can be minimised by improved grain-storage practices. Many of the plant diseases are transmitted by insects. The intensity of pest attack varies, which may lead to either partial or complete crop failure. The following are some of the insects which affect plants:

Chewing insects: The larvae and adults of grasshoppers and beetles damage the crop by feeding on the foliage and tender grains. They either bite or chew the plant parts.

Sucking insects: Plant bugs, aphids, leaf-hoppers, etc. are some examples. These insects usually attack in swarms. They suck the cell sap by piercing through the epidermis of the vegetative parts and developing grains. These are also responsible for transmitting viral diseases.

Stem borers: The larvae of some insects bore

into the stem and feed on the inner tissues. This leads to the withering of the main shoot. The examples are rice stem borer, wheat stem borer.

Water weevils: The American water weevil or root maggot sometimes infests paddy fields throughout the growing season. The larvae feed at the base of leaf sheaths and then on the roots. The adult feeds on the leaves but does little damage.

Nematodes: Considerable loss of crop may be caused by nematodes. The nematode gains access to the plant cell contents by piercing the cell wall with a hollow tubular stylet. The wounds or lesions weaken the plant and pave the way for the entry of fungal and bacterial pathogens.

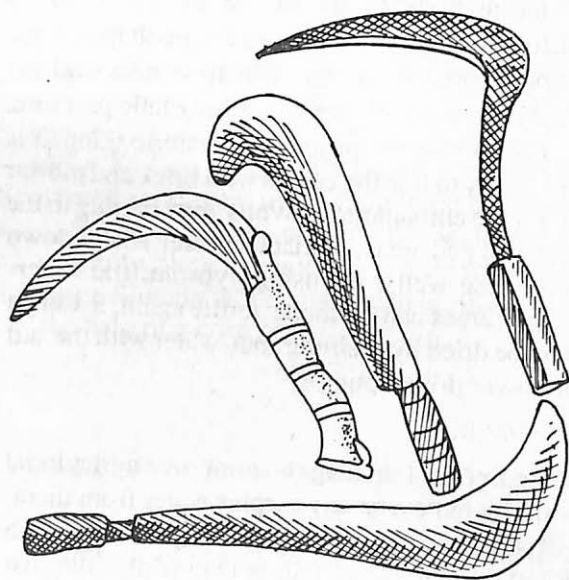


Fig. 5.4 Sickles for harvesting

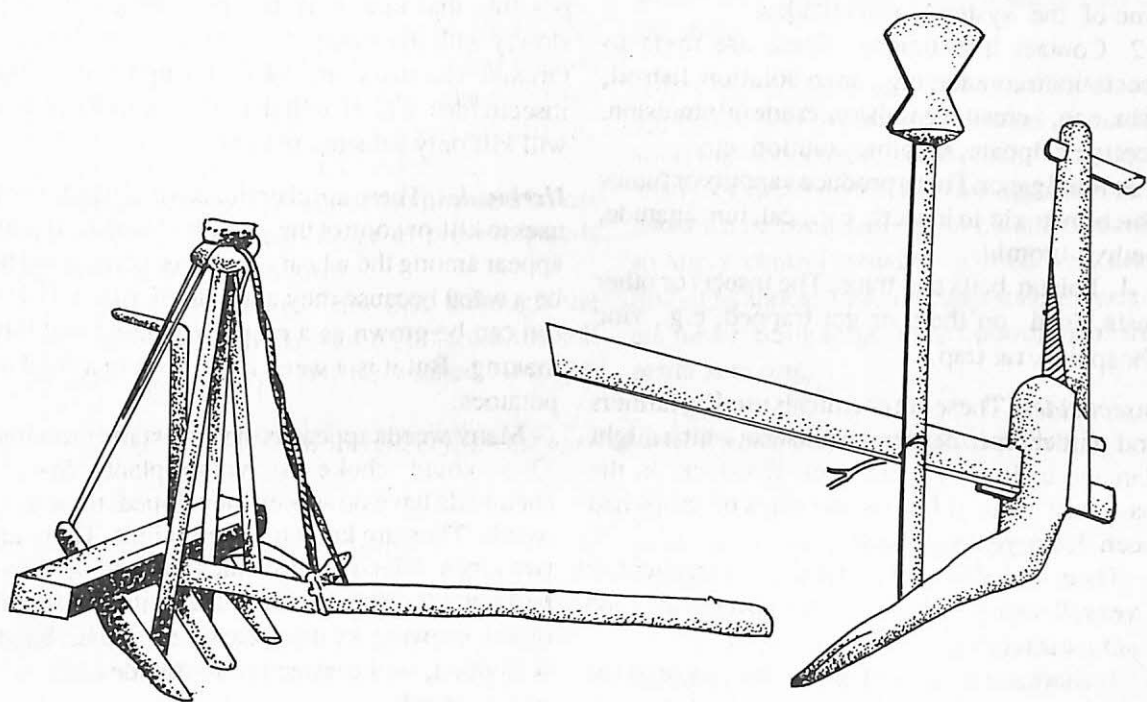


Fig. 5.5 Different types of seed drills

Crabs: In most tropical countries, sea and land crabs are responsible for considerable damage to paddy by feeding on seedlings and burrowing into the bunds, thereby interfering with irrigation.

Birds: Birds are a serious problem in the paddy fields, causing heavy loss of grain, especially where the crop is confined to a strip.

Snails: The most costly pests of paddy are the water snails which destroy young seedlings over large areas of newly sown paddy.

Termites and white ants: The attack begins at the roots and spreads to the aerial parts. This results in the withering of the plant.

Storage pests: Weevils attack paddy and wheat during storage. They feed on the grain, and lay eggs inside the grains. After hatching, the larvae eat up the grain.

Locusts: Locusts closely resemble grasshoppers. They fly over long distances during migration. They destroy crops and can wipe out vegetation.

In addition to insects, several other animals, too, destroy the crop. Birds like sparrows, parrots and pigeons consume a considerable amount of the grains. The worst animal pest is the rat. Rats destroy plants in the field, and grains in godowns and homes.

CONTROL OF ANIMAL PESTS

Plant quarantine: As in the case of plant diseases, quarantine measures are essential in case of imported varieties. Steps must be taken to see that insects are not transported into the country at various ports of entry.

Chemical control: 1. Systemic insecticides: These persist in the plant body and continue insecticidal function for extended periods.

Lead arsenate, dimecron, nuvon, polythion are some of the systemic insecticides.

2. Contact insecticides: These are toxic to insects upon contact, e.g., soap solution, fish oil, resin soap, kerosine emulsion, crude oil emulsion, nicotine sulphate, nicotine solution, etc.

3. Fumigants: These produce vapours or fumes which are toxic to insects, e.g., calcium cyanide, methyl bromide.

4. Poison baits and traps: The insects or other pests feed on them or get trapped, e.g., zinc phosphide, rat trap.

Insecticides: These are chemicals used by farmers and gardeners to destroy any insects which might damage their plants and their livestock. In the past, vast areas of forests and acres of crops had been destroyed by insects.

There are three basic types of insecticides: *stomach insecticide*, *systemic insecticide* and *contact insecticide*.

1. Stomach insecticides are sprayed onto the plants and consumed by the insects along with the foliage which they feed on.

2. To deal with insects which feed on the sap of plants, a systemic insecticide is used. It is absorbed by the roots of the plant and carried round in the sap. It does not affect the plant but kills the insects.

3. Contact insecticides are by far the most widely used type of insecticide. They kill the insect on contact, as the name suggests. Insecticides such as D.D.T and B.H.C (benzene - hexachloride) are extensively used in controlling external parasites on farm animals, as they are not harmful to the animals themselves.

However, there are some disadvantages in the use of insecticides. It has been found that D.D.T and similar insecticides have some unwanted side-effects. They are very slow to decompose, and although they are washed out of the soil by rainwater they can reach streams and rivers, where they kill all life. At the same time, insectivorous birds and mammals have been killed in large numbers through eating insects which

have been poisoned by insecticides. It is possible that man may be poisoning himself slowly with the use of some of these insecticides. Organic chemists are now trying to develop insecticides which will decompose quickly and will kill only selected insects.

Herbicides: These are chemicals which the farmer uses to kill or control the growth of weeds. If oats appear among the wheat crop, it is considered to be a weed because they are out of place. Grass too can be grown as a crop for grazing and hay making. But it is a weed if it grows in a field of potatoes.

Many weeds appear as the crop starts growing. They could choke the young plants. Special chemicals have now been developed to destroy weeds. They are known as herbicides. There are two kinds: selective herbicides and non-selective herbicides. Non-selective herbicides kill all plants growing in the area where the herbicide is applied, while selective herbicides kill only certain weeds.

1. Non-selective herbicides: The most important of them are oils, arsenic and sodium chlorate.

a. Oils: These are unsaturated hydrocarbons such as paraffin, diesel oil and some petroleum products. They are sprayed on to the leaves of the weeds. They work by preventing the leaves from breathing properly.

b. Arsenic: This is absorbed through the roots and leaves of plants. It is absolutely deadly to them. But fields which are treated with arsenic may remain sterile for many years. Moreover it is a dangerous herbicide since it is poisonous to human beings and livestock as well.

c. Sodium chlorate: This is absorbed through the roots and leaves of the plants. It is used to kill patches of persistent weeds in grassland. This herbicide may explode when it is dry.

2. Selective herbicides: These are man-made chemicals and they fall into two main groups.

Those in the first group kill selected weeds by upsetting their growth balance. They work

through the roots. They usually need 2–6 weeks to take effect.

The second group contains herbicides which work on the leaves of the weeds rather than on the roots. They prevent the plant from manufacturing important sugars and so kill them. They take 2–5 days to take effect.

Many herbicides are applied as powders before the crops are sown, in order to prevent weeds from even starting to grow.

The disadvantages are that although the herbicides seem to be washed off from the soil by rain, in fact they can be washed into the

drainage system and eventually reach streams and rivers, often with devastating effects on the life there.

Spraying or dusting: These pesticides can be applied either as dusts or sprays. A variety of spraying and dusting equipment is available. Many of these pesticides are highly poisonous and must be used with great care. It is advisable to apply control measures immediately after the first signs appear. In some cases state governments are undertaking large scale control measures by aerial spraying.

Activity 9: Invite an officer from the agricultural department to give a talk on 'pest control'.

5.8 Harvesting and threshing

The method of harvesting depends on the type of crop to be harvested. There are modern machines now that can lift root crops, clean them, top and tail them and package them.

Crops like hay are mown. The mower consists of a steel bar which holds a series of long knives made up of sharp triangular sections. These move backwards and forwards at high speed between fixed blades. In the case of hay, a device is often attached to the mower which tosses the hay into the air to help it dry. The mown hay is usually left on the field for several days to dry, and is tossed or turned at intervals to speed up the process. If the hay is to be stacked into ricks, it is gathered up with wooden fork-lift devices attached to the front of the tractor, dumped in a cart and then taken to the site of the rick, where it is lifted onto the top of the rick by a *mechanical elevator*.

The two important operations in harvesting corn are, therefore, the cutting of the corn and the threshing, which is beating the grain out of the ears. In the olden days and in many parts of the world still today, the corn is cut by hand with a *sickle*. It is then *stooked*. Wheat and barley are allowed to stand in the stook for about two

weeks to complete their ripening. Once ripe, the corn is taken to the farmstead where it is threshed by hand with flails, on the floor of a barn. The first step forward in the mechanisation of harvesting was the development of a reaper to do the cutting operation. It had a mechanical knife, like a mower, and could also bind the corn into sheaves for stooking. Later, threshing machines which beat the grain out of the ear mechanically were invented.

Finally, these two different devices were combined into one machine, the *combine harvester*. This is a large, usually self-propelled machine which moves across the corn field cutting the corn as it goes. It then separates the ears from the straw, threshes the ears to remove the grain, grades the grain and pours it into sacks or bags. The 'dead' ears are then tossed back onto the field as chaff, which can either be left to rot or else ploughed in. The machine also deals with the straw, which is either chopped up into chaff or bound up into bales.

The most harmful method of threshing is by foot, oxen or tractor wheels, as it breaks the grain. In some countries, the sheaves are brought to the threshing floor where they are sun-dried. Sheaves are laid round a stake with the head towards the stake. Buffaloes or cows are then driven round

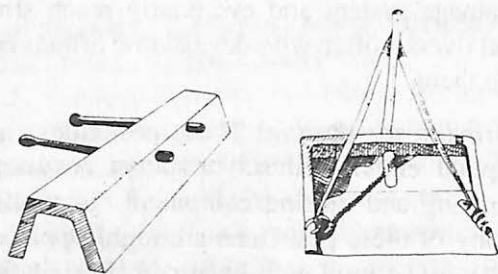


Fig. 5.6 Soil levellers.

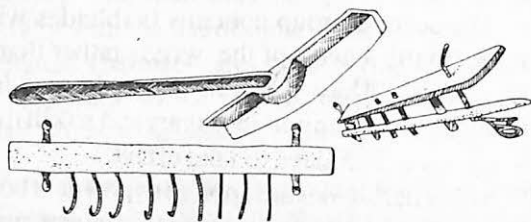


Fig. 5.7 Clod crushers.

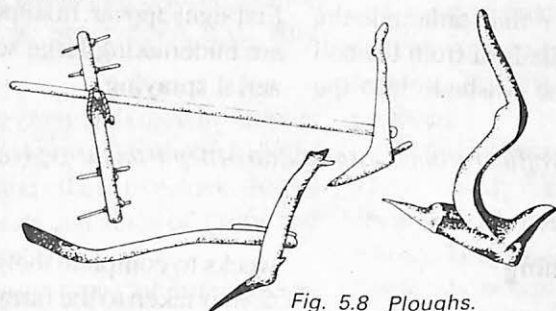


Fig. 5.8 Ploughs.

to trample out the grain. Less commonly, threshing is done by beating the sheaves against

a block of wood. Threshing combs are said to have been invented in Japan.

Activity 10 : Visit a field and find out the harvesting method in operation there.

5.9 Storage — godowns, cold storage

Storage means keeping the harvested fruits till they are taken finally to the consumer. Seeds are stored to protect them from birds, insects, rodents and microorganisms and also for use during periods of food scarcity.

GODOWNS

Seeds can be thus stored for many years. In the olden days, people used clay pots, woven baskets or even holes in the ground to store seeds. Seeds

can also be stored in a barn or godown for many years. These godowns should be protected from animal pests. They can be fumigated by pesticides. They are then left for some days and after that the seeds can be stored in them. The seeds are first dried before they are stored.

COLD STORAGE

This is called the refrigeration method. Fruits and seeds are packed in standardised boxes or other containers and stored in a refrigerated room.

Activity 11 : Visit a grain storage godown and find out the problems encountered and how they are dealt with.

5.10 Conservation of natural resources, creation of awareness of conservation of natural resources

In class 7 we learnt that trees provide food and shelter to human beings. We also learnt about

man's role in the deterioration of the environment.

Now we will learn about the different ways in which we can conserve natural resources. Man depends completely on the different resources in nature. These resources are of two

types. They are renewable and non-renewable. Renewable resources include soil, water, forest, vegetation and wildlife. Minerals, oil and coal are non-renewable resources. We have already seen how developing industries require large quantities of timber, coal, oil and water. As the population grows, people need more food, and therefore man needs more land to produce food. Man has therefore been destructive and wasteful. A large number of forests are being destroyed. This results in soil erosion and floods, causing heavy loss of life and property. Many species of plants and animals have been destroyed. End products of the life processes of other living organisms are recycled into nature but the wastes resulting from man's productive activity are excluded from the cycle. Yet, man depends on

soil, animals, coal, oil and minerals for his basic necessities of life. However, these are not inexhaustible. He has, only of late, begun to think of these in terms of his own future needs.

Man faces two problems. He has to ensure the availability of resources for the growing population. He has to preserve the natural environment in a state suitable for life as well. He has to find solutions for these problems. Measures are already being taken to afforest barren lands and to reduce pollution. The consumption of natural resources has to be within the limits of their possible restoration or return to nature. For example, timber used should be in proportion to what is growing in the forest. Soil has to be replenished by returning to it most of its components that are removed during cropping.

Activity 12 : Demonstrate soil erosion by water and wind.

5.11 Non-renewable and renewable resources

Renewable resources are those which can be restored to nature. Non-renewable resources are those which, once used, are exhausted for ever.

Wise use of non-renewable resources is therefore important. For example, coal gives us energy, but once mined and burnt it cannot be restored. Some metals can be used again and again, but the original material is finally lost through oxidation and other processes. Thus the stock of non-renewable resources diminishes. So it is evident that a balance should exist in nature as an interdependent cycle involving water, soil, forest and wildlife. Man has now realised to a certain extent that direct and indirect interference often upsets this balance.

CONSERVATION OF WATER

Water can be conserved by holding as much of

rain water as possible in the region where it falls, especially in the hills which serve as catchment areas. This is possible by allowing vegetation to grow on the hill slopes. Therefore, afforestation in these areas is important also because it reduces silting. Plants bind the soil and help it to hold the water. Dams which are constructed near catchment areas retain water and regulate the supply of water to the fields. They also maintain a constant flow of water in the rivers.

Water is mainly polluted by sewage and industrial wastes. In some places there are special sewage systems. The sewage is first treated and the water alone is released into the rivers. The solid, putrified matter is used as manure. In many factories arrangements are made to filter out industrial wastes. People should be educated to use and maintain resources properly.

Activity 13 : Make posters to encourage methods of soil and water conservation.

SOIL EROSION

Soil is created from hard rock by the action of heat, cold, wind and water. But these same agencies can also destroy soil and when this happens the process is called erosion.

1. *Wind erosion:* Loose, dry top soil is blown away by the wind. This type of soil erosion is common in areas receiving less than 375 mm rainfall.

2. *Water erosion:* a) Sheet erosion: Here the whole top soil is washed away. b) Gully erosion: This happens when small rills or channels develop into larger gullies.

Erosion by wind: If there is no green layer or vegetation to cover and protect the soil, it is simply lifted off the land and blown away in great dust clouds. This happens in arid lands and along the sand shores of oceans, lakes and rivers. When grass is ploughed up, the stability of the soil is drastically upset. Cultivated soil deprived of the binding effect of grass roots and spongy organic matter becomes much less cohesive. Organic matter disappears because of decay and oxidation. After periods of drought, the soil turns into a dry powdery mass. The loose, dry particles, which are lighter, are swept away by the wind over long distances. The coarser, less fertile grains of sand are blown along near the surface as ground drift.

The sand is constantly blown away from one place to another. Anything that comes in the way is covered with sand. The agricultural fields which lie in the path of the wind are soon covered with sand and become unproductive in course of time. Shifting sand dunes are a common feature in deserts.

Erosion by water: Water erosion is the movement of soil by rain water, or melted snow, running rapidly over exposed land surfaces. If there is a thick cover of vegetation the rain water is partly soaked into the ground, partly absorbed by the vegetation and is partly evaporated. Erosion of

soil is negligible due to the absence of surface run-off. Two types of erosion by water are described below.

a. *Sheet erosion:* Once the soil has lost its ability to absorb water, rain water simply runs off the surface, taking the soil with it. It removes soil in thin layers, one at a time, from an entire field. Surface markings are usually not prominent. This results in the appearance of light coloured soil on account of the removal of the dark top soil. If the land is bare and the rainfall is heavy, the rain drops beat the soil surface and break it into very fine pieces which plug the soil pores. The soil becomes compact and non-porous. The rate of infiltration of water into the soil decreases and so the rain water has a rapid run-off. The run-off is much faster if the land has steep slopes. This results in sheet erosion of the soil.

b. *Gully erosion:* Gully erosion is also caused by rain falling on soil that has lost its ability to absorb water. This is usually caused by torrential rainfall, and it usually occurs where there is no vegetation left to prevent the flow of the rain water. Streams in mountainous areas flow at high gradients in narrow steep-sided V-shaped valleys. They are vigorous, and actively erode the bottom of their channels. As the rain water rushes off the land it forms small rivulets in the soil. With each successive rainfall, these rivulets grow larger and larger and more and more soil is washed away. During erosion, the fertile portion of the soil is lost in the uplands, and the same causes silting over of the vegetation of adjoining lowlands.

Causes for soil erosion: The major cause of soil erosion is the removal of a vegetation cover. This exposes the top soil to wind and water erosion. The reasons for this are as follows: a) Overgrazing by animals destroys the grass cover. b) Deforestation, i.e., the forest-cover is removed by burning or cutting of trees. c) Up and down slope ploughing. d) Over-cultivation which weakens the soil structure.

CONSERVATION OF SOIL

The following are some methods of conserving soil:

1. *Irrigation and drainage*: The water that flows from the land should not carry the top soil along with it. Intensive cropping and use of proper drainage canals are very effective.

2. *Reforestation*: Reforestation, that is planting suitable, quick-growing plants to give a proper plant cover, is very helpful. The planting of *shelter-belts* (belt of tall trees) and other tall trees acting as *wind breakers* at right angles to the direction of the wind prevents soil erosion. Planting of trees that will hold the soil will help in checking the shifting of sand. These are called *binders*, e.g., *Saccharum munja*, *Cynodon dactylon*, *Saccharum spontaneum*.

3. *Contour planting*: Ploughing up and down the slope causes quick run-off of water and loss of top soil by sheet erosion and gulying. Ploughing at right angles to the slope checks the flow of water straight down the hills, and soil erosion is prevented. Rain water is also held back for a long time in the crosswise depressions and is therefore absorbed in larger quantities.

4. *Contour strip cropping*: On contoured slopes clean-cultivated crops are planted between strips of cover crops, such as legumes, which prevent run-off and hold the soil. The alternate strips of dense-growing and soil-covering crops prevent soil erosion.

5. *Terracing*: The slope or undulating hill areas are divided into series of small flat fields by means of ridges or *terraces*. They are placed in such a manner that they catch and hold water. This slows down the run-off rate and helps to minimise the dangers of soil erosion. This method also reduces the gradient of natural slopes to aid cultivation by allowing water to soak in. This breaking up of long slopes into small watersheds channelises water to the sides of the fields, thereby preventing soil erosion.

6. *Basin listing*: In certain cases deep furrows are maintained (listing) and crops are planted at the bottom of the furrows. Water and snow are held in these furrows. At regular intervals cross-dams are made which may reduce the flow of water further.

7. *Dams*: Big dams are constructed in the headwaters of rivers. Such rivers control floods effectively.

8. *Controlled grazing*: Excessive grazing makes land comparatively bare. The soil particles become compact under the impact of the hooves of animals. Rain water cannot soak into such a soil and there is a quick run-off. Finally the soil becomes dry, and the rhizomes and roots of the plants become weak. The holding capacity of the soil also becomes low. Such a soil is dry and weak and is easily eroded. Only a strong and conscious check on overgrazing can prevent this type of soil erosion.

9. *Soil fertility*: Sterile soils or soils lacking in minerals and humus, etc. do not support vegetation. Humus content is low and the water-holding capacity of the soil is also low. There is faster run-off, and if there is no vegetation, it causes soil erosion. Soil fertility can be increased by the addition of manure and chemical fertilisers. *Crop rotation* is one of the important methods to be followed to increase soil fertility. Leguminous plants should be grown alternately with the non-leguminous plants.

CONSERVATION OF WILDLIFE

A large number of wildlife species have become extinct in the course of time, or have been facing extinction. Since the year 1600, three hundred and fifty-nine known species of animals have become extinct. Now the lion, tiger, leopard, cheetah, rhinoceros, Indian wild ass, Kashmir stag and musk deer are facing extinction. Some birds like the Indian bustard and the pink-headed duck are also becoming rare.

A number of national parks and sanctuaries have been established in India to conserve indigenous fauna. In these sanctuaries, hunting and trapping of animals and birds are prohibited. Periodic census is taken to study the numerical status of the populations.

The conservation of wild flora and fauna of a place has been felt to be as essential as that of soil and water. This needs to be preserved in an unmodified condition not only to maintain the balance of nature but also for studying the ecological relations of plants and animals in natural habitats.

CONSERVATION OF FOREST

Conservation of forest involves economy in lumbering, prevention of forest fires, control of insects, pests and diseases, planting new trees and preservation of wild animals.

Almost two-thirds of a tree is wasted between the time it is cut and the time it is converted into a finished product. Sometimes only a part of the tree is cut into logs and the other part is left to decay. Forest fires also cause damage to the forests. When trees are cut for timber, firewood and other purposes, they should be replaced by planting new trees. Forest fires and plant diseases should be prevented. In recent years, national parks and conservation forests have been established for this purpose.

CONSERVATION OF WATER

Human population is increasing day by day. This leads to tremendous increase in demand for water. The falling water table, particularly in densely populated countries, has influenced vegetation to a great extent. In Britain, due to shortage of water, eight species inhabiting wet places like bogs, fens or salt marshes have become extinct in the past few years. Shortage of water and too much of water are both harmful to the plant community. The governments of various countries have launched many programmes to conserve, retain and store water.

Dams and reservoirs are built to control floods

and to regulate the supply of water for irrigational purposes during the dry months. Control of water pollution caused by chemical pollutants of the industrial wastes, sewage, etc. helps to conserve water. Water can be conserved by holding as much of rain water as possible in the region where it falls, especially in the hills which act as catchment areas. This can be done by allowing vegetation to grow on hill slopes. So afforestation in these areas is important. Plants bind the soil and help it hold the water. Such plants are called binders.

Water is polluted by sewage and industrial wastes. In certain places, the corporations or municipalities have sewage plants. Sewage is first putrified and the water alone is released into the river. The putrified matter is used as manure. In many factories, industrial wastes are filtered out.

5.12 Vanamahotsava and Chipko Movement, social forestry and participation of schools, wildlife sanctuaries, parks and zoos

VANAMAHOTSAVA

On the steep hillsides where soil erosion is severe, the need for soil conservation becomes more significant. Reforestation, i.e., planting suitable, quick-growing plants to give proper plant cover, is the easiest way to prevent erosion. The planting of shelter-belts and other wind-breaks prevent soil erosion by wind. In arid conditions, soil-binding species like *Saccharum munja*, *Saccharum spontaneum*, *Cynodon dactylon*, etc. are grown to check the shifting of sand.

In India, Vanamahotsava Week is celebrated every year to emphasise the need for suitable plant cover everywhere. A large number of trees are planted to make up for the repeated loss of natural vegetation.

SOCIAL FORESTRY

The concept of social forestry has now been recognised and accepted by the Government of

India and is being implemented on a massive scale. This aims at not only generating adequate quantities of fuel wood, fodder and other forest produce but also at maintaining ecological balance through large scale afforestation on community lands and wastelands. Farm forestry, which has been largely practised in the country so far, aims at growing trees on private lands, on farm boundaries and private plantations. The social forestry programme comprises three schemes: 1) mixed plantation on wastelands, 2) re-afforestation of degraded forests, and 3) raising of shelter-belts. This social forestry involves creating potentialities of forest raw material resources on degraded forest areas, wasteland, panchayat land and on the sides of roads, canals

and railway lines. Under the social forestry schemes, fuel wood plantations are grown for raising quickly the supply of fuel, wood and fodder.

PARTICIPATION OF SCHOOLS

Students can take part in the Vanamahotsava celebration by planting a few saplings in their schools and private gardens. They can tell people about the importance of growing trees and also about the harmful effects of felling trees unnecessarily. Some areas near the schools can be used for growing different kinds of trees.

Students can also take part in the celebration of the wildlife week and social forestry week.

Activity 12: Observe the various methods of soil and water conservation in your area and prepare a report.

Activity 13: Take part in the celebration of Vanamahotsava, wildlife week and social forestry week.

WILDLIFE SANCTUARIES AND NATIONAL PARKS

In November 1952, the Indian Board for Wildlife was established. From July 1955 every year, wildlife week has been observed. There are many wildlife sanctuaries and national parks in our country for conserving wildlife.

The Mudumalai sanctuary in the south is famous for its wide range of fauna. The Bandipur sanctuary in Karnataka, the Vedanthangal bird sanctuary in Tamil Nadu, Guindy deer park and snake park in Madras, Mundanthurai sanctuary for tigers in Tirunelveli, the Periyar sanctuary in Kerala, the Kaziranga (Assam) and Jaldapara (West Bengal) sanctuaries for rhinoceroses, the sanctuary in Bharatpur (Rajasthan), Corbett National Park (Uttar Pradesh), Kanha National Park (Madhya Pradesh) and Hazaribagh National Park (Bihar) are some of the important conservation centres in India.

Bandhavgarh national park (Shahdol-Madhyapradesh), Bannarghatta national park (Bangalore

-Karnataka), Chandraprabha sanctuary (Varanasi -Uttar Pradesh), Melapattu bird sanctuary (Nellore - Andhra Pradesh) and Sundarbans tiger sanctuary (West Bengal) are also important wildlife sanctuaries in India.

CHIPKO MOVEMENT

The Home Ministry of the Government of India appointed a committee to study the conditions of the forests in India. The committee, chaired by well known tribal anthropologist B.K. Roy Burman and several senior forest officials, submitted its report in October 1983, but no decision has yet been taken on its recommendations. The committee argues that people must be involved in forest management. The committee pleads that any new forest policy should recognise the positive role of the local people. It cites successful experiences in community management of forests in some north eastern states and in popular movements like Chipko.

Chipko movement is one which is formed to prevent the felling of trees. In Karnataka it is known as 'Appiko' which means 'to hug', and it began in late 1983. 'Appiko' has essentially given articulation to the people's anger and their feeling of frustration. Not knowing how to protect the trees, the idea of hugging the trees gave them hope.

This movement was first sparked off on September 8, 1983, by the forest department's felling of trees in Sulkanie forest in Sirsi district. Within months the movement had spread to the adjoining districts. In Kalase, the activists of this

movement not only hugged the trees but performed a 'puja' to appeal to the religious sentiments of the people.

The effects of indiscriminate felling first began to be felt in 1960. Lately, the effects of this movement increased dramatically. Pandurang Hegde is one of Appiko's activists. He had earlier been associated with Sundarlal Bahuguna and brought with him his experiences of forest and forest department to Karnataka.

Chipko's aim is to utilise the people's energy to protect and plant trees and to teach the people to use forest resources wisely.

Some basic concepts

1. Preparation of soil, selection of seeds, sowing and transplanting, weeding, manuring, irrigation, crop protection, harvesting, threshing and storage are the different processes involved in agricultural practices.
2. Ploughing or tilling is done with the help of clod crushers, ploughs levelers, etc.
3. Seeds free from diseases and of good variety are selected.
4. Two methods of sowing are broadcasting and the use of seed drills.
5. The practice of taking the seedlings from the nursery to the main field is known as transplanting. This can be done by hand or by machines.
6. Removal of weeds can be done either by pulling them out by hand or by using a plough or harrow. They can be destroyed using certain chemicals like 2, 4-D, MCPA, Simazine, etc.
7. It is necessary to replenish the exhausted soil nutrients by the application of manures. The different types of manure are farmyard manure, compost and green manure.
8. Plants can be irrigated by watering, percolation of water, logging, drainage, seepage, furrow irrigation and basin irrigation. Crops can be irrigated by wells, tanks, lakes and canals.
9. Crops should be protected from pests by use of pesticides which can be in the form of systemic pesticides, contact pesticides, fumigants, poison baits and traps.

10. The crop should be reaped either manually or by machines known as combines. Grains are separated from the chaff by threshing with combines or by animals which are made to tread on them.
11. The grains are then stored in large bins or granaries. Most of the fruits are stored by cold storage.
12. Man has realised that he must conserve nature and its resources. Natural resources are of two types: renewable and non-renewable. Soil, water, forest and vegetation are renewable resources and minerals, oil and coal are non-renewable resources.
13. There are many methods to prevent soil erosion. They are terracing and binders. Even controlled grazing prevents soil erosion.
14. Water is drained from large areas of lands. Dams and reservoirs are built to control floods and regulate the supply of water for irrigational purposes.
15. The animals and plants in forests have to be conserved to maintain an ecological balance.
16. Vanamahotsava and the Chipko Movement have brought about an awareness in people to conserve the plants and trees. The celebration of wildlife week stresses the importance of the conservation of animals.

REVISION TIME

I. Fill in the blanks:

1. Turning over the soil by a few inches is called _____.
2. Scattering seeds by hand is called _____.
3. The practice of transferring the seedlings from the nursery to the main field is called _____.
4. Manuring is a method to replenish the exhausted _____ by the application of manures.
5. Removal of the weeds from the field is called _____.
6. Combine harvester is a machine used for _____.
7. Grains are separated from the chaff by _____.
8. Terracing is a method to conserve _____.
9. The movement to prevent felling of trees is called _____.
10. Pests can be controlled by _____.

II. Answer the following questions:

1. What is agriculture?
2. What is irrigation?
3. Why is manuring necessary for the soil?
4. Name any one wildlife sanctuary in Tamilnadu.
5. Name a few insect pests that affect plants and state which parts of plants are affected by them.
6. What are the agents which cause soil erosion?
7. What are weeds?
8. Name the two types of natural resources.
9. How did the 'Chipko Movement' start? And what is its aim?

III. Write short notes on the following:

1. Chipko Movement.
2. Conservation of soil.
3. Preparation of soil for cultivation.
4. Manures.
5. Conservation of wildlife.
6. Sowing and transplanting.
7. Seepage.
8. Irrigation.
9. Any five implements used in agriculture.
10. Harvesting.

IV. Write essays on the following topics:

1. The steps involved in agricultural practices.
2. Pests and the pest control.
3. The conservation of natural resources.

V. Match the following:

- | | |
|--------------------------|--------------------------------------|
| 1. Plough | implement used to harvest. |
| 2. Terracing | sowing of seeds by hand. |
| 3. Broadcasting | is used to turn the soil. |
| 4. Clod crusher | method to conserve soil. |
| 5. Sickle | is used to break big chunks of soil. |
| 6. Corbett National Park | method to conserve wildlife. |
| 7. Periyar sanctuary | Uttar Pradesh. |
| | Kerala State. |

6. Economic Biology

economic biology - uses - antibiotics, alcohol, medicines, organic acids and food - bacteria - fungi - uses of algae.

It has been said that Botany is the most fundamental of all sciences. As civilization advanced man gave more and more time to the study of useful plants. Most of the world's important economic plants are grown in India. Scientists have studied plants from various points of view, e.g., the study of field crops, medicinal plants and microorganisms. These are, taken as a whole, called Economic Botany.

6.1 Uses — antibiotics, alcohol, medicines, organic acids, food, bacteria, fungi

ANTIBIOTICS FROM FUNGI

Antibiotics are substances produced primarily by certain harmless microorganisms that are injurious to the growth and activity of various pathogenic bacteria and other microorganisms.

Penicillin: This is obtained from *Penicillium notatum*. When grown on gelatin, the mycelium excretes penicillin into the substratum, which becomes liquid. Other species of penicillium, especially *P. crysogonum*, also furnish the antibiotic.

Streptomycin: This antibiotic comes from *Streptomyces griseus*. Streptomycin is particularly effective against Gram-negative bacteria and is used in the treatment of urinary and local

infections and some forms of tuberculosis, meningitis and pneumonia.

Aureomycin: Aureomycin is produced by *Streptomyces aureofaciens*. It is used to treat viral pneumonia, fever, osteomyelitis, whooping cough, and eye infection.

Chloromycetin: This is a pure crystalline substance produced by *Streptomyces venezuelae*. It is useful in the treatment of undulant fever, bacillary urinary infections, pneumonia and typhoid fever.

Terramycin: This is secreted by *Streptomyces rimosus*. It is valuable in treating common forms of pneumonia, typhoid fever and many intestinal and urinary tract infections.

ANTIBIOTICS FROM ALGAE

Chlorellin: Chlorellin is obtained from the alga *chlorella*. Chlorellin inhibits the growth of other bacteria.

Extracts of *cladophora* and *lyngbya* possess antiviral properties and kill strains of certain bacteria.

ANTIBIOTICS FROM BACTERIA

1. *Tyrothricin* — from spore forming aerobic soil bacterium.

2. *Bacitracin* — isolated from contaminated wound.
3. *Polymycin* — from spore-forming soil bacterium.

ORGANIC ACIDS FROM FUNGI

Mucor nuxii and *Mucor oryzae* change starch to sugar which is to be fermented later by yeasts in the production of alcohol.

Yeasts are known for their ability to ferment carbohydrate. As a result of fermentation, alcohol and carbon dioxide are formed. Wild yeasts are used to bring about fermentation in wine and cocoa.

Aspergillus niger is used for the manufacture of citric acid and gluconic acid. Several species of penicillium are able to produce organic acids, such as citric acid, fumaric acid, oxalic acid, gluconic acid and gallic acid.

ORGANIC ACIDS FROM BACTERIA

Lactic acid is formed when corn sugar or molasses are fermented.

Vinegar is prepared by the action of acetic acid bacteria on the juices of fruits like apples, pears, plums, grapes, etc., e.g., *Acetobacter aceti*.

Butyric acid is obtained by the fermenting action of butyric acid bacteria, *Bacillus amylobacteria*.

Acetone-butyl alcohol producing bacteria act upon molasses under anaerobic conditions. As a result *butyl alcohol*, *acetone* and *ethyl alcohol* are formed.

MEDICINAL USES OF ALGAE

Many sea weeds have a high percentage of iodine content and thus are employed in the preparation of goitre medicines or are administered directly as a powdered meal. Some examples are *Laminaria japonica*, *Laminaria religiosa*, *Codium intricatum*, *Gelidium*, *Fucus* and *Ecklonia*.

Agar-agar is an important algal product used in the manufacture of pills and ointments. It

forms a base for many kinds of medicines used as laxatives.

FOOD

Food is necessary for the existence of all living things. The essential foods — carbohydrates, fats and proteins — are all available in plants. So too are mineral salts, organic acids, vitamins and enzymes, which are also necessary for the well-being of man.

Lower plants as sources of food: Fungi like yeast, mushrooms, truffles, morels, etc. constitute one of the sources of food for man. Yeasts have a high vitamin value content and are therefore particularly valuable as food. Mushrooms contain protein and vitamins. Some species of *Agaricus* are edible. *Pleurotus ostreatus* is edible and has an excellent flavour. The fruit bodies of the species of tuber commonly known as truffles have been considered to be as delicious as mushrooms.

Morchella esculenta is an aromatic fungus which is commonly known as the *morel*. It is an edible fungus. It is a popular food in the United States.

Use of algae as food: Seaweeds have been extensively used as food by the Chinese and the Japanese from very early times. The red algae *Porphyra* is an important article of food.

A few species of *Rhodomenia* such as *Rhodomenia palmata* and *Chondrus crispus* are used as condiments and as ingredients in soups. *Oedogonium* and *Ulva* are other examples.

Sometimes blades of *Laminariales* are cut, fried and eaten, with or without salt.

Algae are considered rich in proteins, fats and vitamins A, B, C and E. *Diatom Nitzschia* contains vitamin A. Vitamin B is found in *Ulva*, *Enteromorpha*, *Laminaria*, *Porphyra* and *Chondrus crispus*.

MEDICINAL PLANTS

From the earliest times, man has been using

plants in an attempt to cure diseases and relieve physical suffering. Primitive people, after trial and error, had some knowledge of medicinal plants. After the Dark Ages, there came the period of the herbalists, and the monasteries of Northern Europe produced vast compendiums of true and false information regarding plants, stressing in particular their medicinal value.

From this crude beginning the study of drugs and drug plants has progressed tremendously.

Some drugs are obtained from roots and other underground parts of plants:

Colchicum autumnale: The roots of this plant are used for diseases of the liver and spleen and in rheumatism. The drug is applied externally, and it reduces the pain and inflammation.

Rawolfia serpentina: Dried roots contain reserpine and some alkaloids. The drug made from these roots reduces blood pressure. It is given when people suffer from mental anxiety, hypertension and fear. It is also used to cure mental illness.

Ipecac: This is indispensable in the treatment of amoebic dysentery and pyorrhea.

Ferula asafoetida: This aids digestion and is also used as a pain reliever and laxative.

Some drugs are obtained from the barks and stems of plants:

Cinchona officinalis: Quinine is obtained from the bark of cinchona. It is used in the treatment of malaria. It is also valuable as a tonic and antiseptic and in the treatment of fevers.

Ephedra sinica, *Ephedra equisetina*: The entire plant body is used for the extraction of the drug. In the United States, ephedrine has been used

extensively in the treatment of colds, asthma, and hay fever, and for other medicinal purposes.

Drugs can be obtained from leaves as well:

Atropa belladonna: The leaves of *Atropa belladonna* contain several alkaloids, the most important one among them being atropine. Belladonna is used externally to relieve pain, and internally to check excessive perspiration. Atropine is used to dilate the pupil of the eye.

Aloe: Aloes are used as purgatives.

Erythroxylon coca: *Erythroxylon coca* contains the alkaloid cocaine which has been used extensively as a local anaesthetic. It is also used as a tonic for the digestive and nervous systems.

Digitalis purpurea: This plant has a glucoside digitoxin. Digitalis improves the tone and rhythm of the heart beats, making the contractions more powerful and complete.

Eucalyptus globulus: The leaves of this plant contain an essential oil that is widely used in medicine. Eucalyptus oil, obtained from dried leaves, is used chiefly in the treatment of nose and throat disorders, malaria and other fevers.

Datura stramonium: The drug stramonium is extracted from the dried leaves of this plant. This drug is used for relaxing the bronchial muscles in the treatment of asthma.

Eclipta alba: The leaves are used in the treatment of jaundice.

The leaves of the following plants are extensively used in the preparation of ayurvedic and siddha medicines. *Abutilon indicum*, *Eclipta alba*, *Phyllanthus niruri*, *Solanum xanthocarpum*, *Solanum trilobatum*, *Ocimum coleus*, etc.

Activity 1: Prepare a report of work done on antibiotics developed from fungal and bacterial sources.

Activity 2: Prepare a table as shown below to bring out the importance of lower plants and higher plants.

Name of the plant	Product	Use

6.2. Uses of algae

Algae constitute an important group of plants. Since they occur very commonly both in fresh-water ponds and scums, they are called seaweeds. In the previous chapter we learnt how algae are useful as food, medicines and antibiotics. *Nostoc*, *Gloeocapsa*, *Oscillatoria* and *Anabaena* are a few of the nitrogen-fixing blue-green algae. Barren alkaline soils are being reclaimed by inducing the growth of these algae which neutralise the alkalinity of the soil by acidic secretions produced as a result of their decomposition.

Chara is supposed to possess certain larvicidal properties. The mosquito larvae are absent in ponds and ditches which have *chara*. *Chara* is also used in fertilizers, polishes, fish culture and sugar purifiers. Marine green algae secrete calcium salts which play an important role in soil fertility.

The dead remains of *Diatoms* have accumulated at the bottom of the seas forming extensive rock-like deposits of diatomaceous earth. This is mixed every year and put to different uses, such as the following:

1. It is used as polishes for silverware, metals and automobiles.
2. Tooth powder and tooth pastes are produced from it.
3. Being highly fire-proof, it is extensively

used for the insulation of steam pipes, blast furnaces and refrigeration plants.

4. Being highly absorbent, it is used to filter oils, the syrup in sugar industries, and as an absorbent for liquid nitroglycerine in dynamite.
5. It is cut up into small pieces and used as light-weight bricks for building fire-proof houses.
6. It is sprinkled on the walls of mines to prevent dust explosions.
7. It is used to test the resolving power of microscopic lenses by looking at the minute marks on the diatom shells.

Some of the brown algae are used as fertilizers, in the manufacture of soap and some valuable medicines.

ALGINATES

Algin is a colloidal substance. The chief sources of alginates are *Laminaria*, *Macrocystis*, *Sargassum* and *Ascophyllum* of brown algae.

Uses of alginates:

1. Suspending and emulsifying agent.
2. Creaming and stabilizing agent in the rubber industry.
3. In the manufacture of flame-proof fabrics as well as plastic articles.
4. Sodium and calcium alginates in the preparation of dental impression material.

5. Thickeners in the cosmetics and pharmaceutical industries.
6. In the manufacture of welding electrodes, sizing of paper and textile industry.

AGAR-AGAR

This is a gelatinous substance used in making jellies, as a medicine and a culture medium in biological laboratories. It is also used as an anti-drying agent in bread and pastry making and in the manufacture of frozen dairy products. Agar is also used in canning of meat and fish. It is used in the sizing of fabrics and water-proofing of paper and cloth. Agar is used in the manufacture of photographic films, dental moulds, hand lotions, shaving soaps and shoe polish. Agar-agar is obtained from red algae or *Rhodophyta* like *Gelidium*, *Gracillaria* and *Gelidiella*.

FODDER

Sea weeds serve as food for cattle, e.g., *Fucus*, *Laminaria* and *Ascophyllum*. Sea weeds contain

a large amount of vitamins and mineral matter.

FERTILIZER

Sea weeds are useful as manure because they contain potassium, trace elements and growth substances. They also contain nitrogen and phosphorus. Blue-green algae are helpful to reclaim saline and alkaline soil. Algae like *Nostoc* are helpful to aggregate soil particles and prevent soil erosion.

SEWAGE DISPOSAL

In sewage oxidation, pond algae play an important role. These algae give out oxygen which helps to increase the oxygen content of the sewage. Then the sewage is safe for further disposal, e.g. *Chlorella*.

SPACE TRAVEL AND SUBMARINES

The algae *Chlorella* is used to regulate oxygen and carbon supply in nuclear submarines and spaceships.

Some basic concepts

1. Antibiotics are substances or secretions which inhibit the growth of other microorganisms.
2. Most of the antibiotics are obtained from fungi — e.g., penicillin, streptomycin, aureomycin, chloromycetin.
3. Some of the fungi are important in the production of alcohol, e.g., yeast.
4. Many fungi are important in the production of organic acids.
5. Antibiotics are also produced by algae, e.g., chlorellin is extracted from *Chlorella*.
6. Many fungi and bacteria serve as food for human beings.
7. The products of algae are alginate, agar-agar, carragenin, etc. which are useful in many ways.

8. Many algae serve as food for human beings and cattle.
9. Algae like chlorella are useful in submarines, spaceships and in sewage disposal.
10. Most of the blue-green algae are used as fertilisers and to prevent soil erosion, e.g., Nostoc.
11. Diatoms are used for the insulation of steam pipes and to filter oils and sugar syrup. They are also used to build fire-proof houses and to prevent dust explosion.

REVISION TIME

I. Strike out the inappropriate words from the following statements:

1. Algae are also known as sea weeds/water grass.
2. Iodine is obtained from Laminaria/Vaucheria.
3. The alga possessing anti-larval property is spirogyra/chara.
4. Agar-agar is a gelatinous/solid material.
5. Soil erosion is prevented by the green algae/blue-green algae.

II. Answer the following questions briefly:

1. What is an antibiotic?
2. What are the uses of penicillin?
3. Name the antibiotic obtained from chlorella.
4. Name any two algae from which iodine is extracted.
5. How is chara medicinally useful?
6. What is the important use of Nostoc?
7. Name any two antibiotics obtained from bacteria.
8. How is alcohol produced?
9. Which antibiotic is useful in the treatment of tuberculosis?
10. Name any two edible fungi.

III. Answer the following questions:

1. List any five uses of algae.

2. How are bacteria economically important?
3. Name any five antibiotics and give their uses.
4. Write down the uses of alginates.
5. Write notes on the economic importance of diatoms.
6. Name a few fungi which are useful in the production of organic acids and list the organic acids produced by them.

IV. Fill in the blanks:

1. *Penicillium notatum* produces the antibiotic _____.
2. _____ is used for the manufacture of citric acid and gluconic acid.
3. _____ is used as culture media for growing algae, fungi, bacteria and tissues.
4. _____ is used as fodder for cattle.
5. Alcohol and carbon dioxide are formed as a result of fermentation of carbohydrates by _____.

TEST PAPER I

I. Fill in the blanks:

1. The binomial system of classification consists of the _____ name and _____ name.
2. Organisms which can be seen only through the microscope are called _____.
3. _____ discovered microorganisms.
4. The outer coat of the virus is called _____.
5. Citrus canker is caused by _____.
6. When bacteria are in clusters they are called _____.
7. The hyphae of the fungus is collectively called _____.
8. The fungus has the _____ type of nutrition.
9. The site of infection in mumps is _____.
10. Root hair is a tubular outgrowth of the _____ cell of the root.
11. _____ is the main part involved in the absorption of water.
12. The part of the stem between two consecutive nodes is called an _____.
13. _____ is positively heliotropic.
14. The stems which are found above the ground are called _____.
15. The formation of new cells in the root takes place in the _____ region.
16. The spring wood and autumn wood together form the _____.
17. The period when the entire growth takes place in a plant is called _____.
18. _____ decides the direction of growth of the plant organs.
19. Nitrogen fixing bacteria convert nitrogen into _____.
20. _____ promotes cell division.

II. Differentiate between the following:

1. Species and genus.
2. Bacteria and virus.
3. Streptococcus and staphylococcus.
4. Vibrio and spirillum.
5. Axillary bud and terminal bud.
6. Systemic and primary manifestations of any disease.

7. Saprophytic and parasitic fungi.
8. Microorganisms and macroorganisms.
9. Tap root system and fibrous root system.
10. Spring wood and summer wood.

III. Define the following:

1. Microorganism
2. Antibiotic
3. Binomial nomenclature
4. Species
5. Virion
6. Vectors
7. Internode
8. Grand period of growth
9. Intercalary meristem
10. Hormones

IV. Write short notes on:

1. Naming families, genera and species
2. The structure of the bacterial cell
3. Any two viral diseases
4. The meristems
5. The biography of Antony Von Leeuwenhoek.
6. The structure and properties of virus
7. Typhoid
8. Vitamins
9. Transmission of viruses
10. Secondary growth in plants

V. Answer the following questions:

1. What is a family and what are the different methods of naming a family?
2. What are the control measures for the following diseases?
a) measles, b) bunchy top of banana, and c) poliomyelitis.
3. What are the symptoms of bacillary dysentery?

4. How are bacteria useful?
5. What are the characteristics of the root?
6. What are the uses of growth regulators?
7. Name the biotic factors that affect growth and explain them.
8. How do you measure the growth rate in a plant?

TEST PAPER II

I. Fill in the blanks:

1. Buds found in any other part apart from the tip and the axil of a plant are called _____ buds.
2. In plants like millingtonia, the buds are found on the _____.
3. _____ is a method to get good varieties of plants.
4. The process by which the fruit is formed without fertilization is termed _____.
5. When any part of the flower other than the ovary becomes the fruit, the fruit is described as _____.
6. A winged achene is a _____.
7. The aggregate fruit is developed from the _____ pistil.
8. When all gametes are similar, they are described as _____.
9. The central portion of the sporangium of *Mucor* is called _____.
10. Plants which live for a number of years are called _____.
11. The method of scattering seeds in the field by hand is called _____.
12. The embryo of the maize seed is called _____.
13. _____ are used to break big chunks of soil into small particles.
14. Removal of weeds from the field is called _____.
15. The Indian Board for Wildlife was established in the year _____.
16. The common name for *spirogyra* is _____.
17. _____ is used in the treatment of urinary and local infections and some forms of tuberculosis, meningitis and pneumonia.
18. *Aspergillus niger* is used for the manufacture of _____ and _____.
19. _____ is isolated from contaminated wounds.
20. *Chara* is supposed to possess certain _____ properties.

II. Differentiate between the following pairs:

1. True fruit and false fruit
2. Follicle and legume
3. Achene and caryopsis
4. Coconut and mango
5. Annuals and biennials

6. Protandry and protogyny
7. Epigeal germination and hypogeal germination
8. Coleoptile and coleorhiza
9. Dioecious and monoecious plants
10. Inundation canal and perennial canal

III . Define the following:

1. Fertilization
2. Alternation of generation
3. Vivipary
4. Agriculture
5. Ploughing
6. Crop rotation
7. A multiple fruit
8. Dichogamy
9. Transplanting
10. Antibiotic

IV . Write short notes on:

1. Artificial vegetative reproduction
2. Simple dry dehiscent fruits
3. Sexual reproduction in spirogyra
4. Asexual reproduction in mucor
5. Advantages and disadvantages of cross pollination
6. Zoophily
7. External conditions for germination
8. Structure of a dicotyledonous seed
9. Harrows
10. Manures
11. Any three insect pests
12. Terracing
13. Social forestry
14. Chipko Movement
15. Medicinal uses of plants
16. Uses of algae

V. *Answer the following questions:*

1. What is meant by vegetative reproduction?
2. What is a schizocarpic fruit?
3. What is melacophily?
4. What are the two methods of sowing? Describe them.
5. What is meant by rural compost?
6. How are termites and white ants harmful?
7. What are the different kinds of soil erosion? Explain.
8. How is conservation of wildlife important?
9. What is the significance of Vanamahotsava?
10. What is the aim of the Chipko Movement?



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